Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Todd Parfitt, Director

October 29, 2020

Mr. Carl Daly
Acting Director, Air and Radiation Division
U.S. EPA Region VIII
1595 Wynkoop St.
Denver, CO 80202

RE: Wyoming Department of Environmental Quality – Air Quality Division's Big Piney, Juel Springs, Moxa, and South Pass Special Purpose Monitoring Stations Ozone Data Influenced by an Exceptional Event: April 28, 2019

Dear Mr. Daly,

On April 28, 2019 the Wyoming Department of Environmental Quality – Air Quality Division's (AQD) Big Piney, Juel Springs, Moxa, and South Pass Special Purpose Monitoring stations experienced exceedances of the 8-hour ozone standard due to a stratospheric intrusion (SI). The AQD has flagged the affected data in exceedance of the National Ambient Air Quality Standards (NAAQS) measured by the ozone monitors at the aforementioned stations as due to an exceptional event under 40 CFR Part 50.14. The AQD is requesting EPA concurrence that the event was exceptional.

The AQD has assembled an exceptional event documentation package. The AQD has determined that the exceptional event package demonstrates a clear causal relationship between the exceedances measured at the Big Piney, Juel Springs, Moxa, and South Pass monitors and the SI observed across this area during this time period.

The AQD sent an Initial Notification Cover Letter and Form to EPA for the April 28, 2019 ozone exceedances on January 14, 2020. The AQD received the EPA Initial Notification Response Letter via email on January 27, 2020. In the response EPA states they have not identified and do not anticipate these data being used in any pending EPA regulatory determination, to formulate or support regulation, guidance or in any other pending EPA decision, position, or action and therefore does not plan to review this event for concurrence. The AQD is submitting this demonstration to EPA so that when the EPA prepares to use these data in any pending EPA regulatory determination, to formulate or support regulation, guidance or in any other pending

EPA decision, position or action, the demonstration will already be available in EPA's records for concurrence review.

Public notice for the intent to flag April 28, 2019 ozone data as due to a SI exceptional event was published in the following Wyoming newspapers on August 23: Casper Star Tribune and Wyoming Tribune Eagle and the following Wyoming newspaper on August 25: Sublette Examiner. The exceptional event documentation package was made available for public comment and the public was allowed thirty (30) days to submit written comments. The documentation package was made available on the AQD's website as well as at the AQD's Cheyenne office. At the close of business day on September 24, 2020 the AQD had received one (1) written comment from the public. The AQD responded to the comment via a letter sent to the commenter on October 20, 2020.

The AQD has flagged the ozone data for hours 0000-2300 on April 28, 2019 in EPA's Air Quality System (AQS) data base. The AQD is requesting EPA to exercise its discretion and concur with the flags placed on the April 28, 2019 ozone exceedances at Big Piney, Juel Springs, Moxa, and South Pass.

In October 2020, the EPA completed the full implementation of the State Planning Electronic Collaborations System (SPeCS) for exceptional events. Cara Keslar is the AQD's designated submitter for exceptional events in the EPA's SPeCS for exceptional events. The AQD will submit the April 28, 2019 SI exceptional event documentation package electronically via the SPeCS for exceptional events.

If you have any questions, please feel free to contact Cara Keslar at (307) 777-8684.

Sincerely,

Darla J. Potter
Air Quality Resources Program Manager
Air Quality Division

[Enclosures]

CC: Richard Payton, U.S. EPA Region VIII (w/o enclosure)
Cara Keslar, WDEQ-AQD Monitoring Section Supervisor (w/o enclosure)

Department of Environmental Quality

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Mark Gordon, Governor

Todd Parfitt, Director

January 14, 2020

Mr. Carl Daly
Acting Director, Air and Radiation Division, EPA Region 8
1595 Wynkoop St.
Denver, CO 80202

Re: Initial Notification of April 28, 2019 Stratospheric Ozone Intrusion Exceptional Event

Dear Mr. Daly,

Attached is an initial notification of a stratospheric ozone intrusion exceptional event that occurred in western Wyoming on April 28, 2019 that led to four (4) exceedances of the United States Environmental Protection Agency's (US-EPA) 2015 8-hour ozone National Ambient Air Quality Standard (NAAQS). The Wyoming Department of Environmental Quality – Air Quality Division (WDEQ-AQD) has evaluated the initial notification and circumstances surrounding this event and represents that it should be evaluated by US-EPA Region 8 as a stratospheric intrusion exceptional event. The exceedances covered by this initial notification are summarized in the table below.

Date	AQS ID	Monitor Name	Owner	Daily Max 8-Hour Ozone Concentration (ppm)
4/28/2019	56-013-0099	South Pass	Wyoming DEQ-AQD	0.077
4/28/2019	56-035-1002	Juel Springs	Wyoming DEQ-AQD	0.072
4/28/2019	56-035-0700	Big Piney	Wyoming DEQ-AQD	0.074
4/28/2019	56-037-0300	Moxa	Wyoming DEQ-AQD	0.071

WDEQ-AQD is submitting an "Initial Notification of Potential Exceptional Event" and flagging the data in US-EPA's Air Quality System (AQS) as per 40 CFR §50.14(c) (2) (i) as a result of elevated ozone concentrations. The AQD would like to request that the Administrator determine this possible event meets the provisions of 40 CFR 50.14 (a) (1) (F) as a regulatory determination made on a case by case basis. The WDEQ-AQD considers this event to be of regulatory significance because of the WDEQ-AQD's reliance on ambient data to determine compliance with the NAAQS at state run Special Purpose Monitors (SPM). Additionally, these data are routinely used by the US-EPA and third party interests in evaluating Wyoming's air quality and developing policy. Finally, two (2) of these exceedances (at the Juel Springs and Big Piney stations) occurred within the Upper Green River Basin (UGRB) non-attainment area (NAA) under the 2010 ozone NAAQS. These reasons demonstrate the need to accurately

portray anthropogenic versus non-anthropogenic or "exceptional" air quality issues to the public by means of excluding exceptional event concurred data from the data record.

It is also the WDEQ-AQD's stance that any exceedance caused by an exceptional event is significant and that it is important to demonstrate to the public the difference between exceedances that are anthropogenic versus those that are non-anthropogenic or exceptional in nature. Properly characterizing these exceedances in the public record and providing scientific evidence supporting the claim of exceptionality is essential to our shared role of serving the public. These data are used by the public, researchers, and other public agencies to make scientific, public health, and policy decisions. These data must be properly flagged and concurred with in the US-EPA's AQS in order for those data to be handled correctly and reflect the monitor design values. Without the critical step of determining concurrence, data is often misused by these entities to support policy decisions that may have consequences on a local or national level. Additionally, the numerous exceedances of the 8-hour ozone NAAQS will affect future years design values, with the potential of a NAAQS violation. As two of the exceedances from this event occurred at stations in the UGRB ozone non-attainment area, correctly flagging and characterizing these data in AQS is especially critical.

Due to the above-mentioned factors, the WDEQ-AQD considers these exceedances to meet the criteria of regulatory significance and requests that the Administrator make a determination under 40 CFR 50.14 (a) (1) (F) that the US-EPA will agree to review an exceptional event demonstration for this event.

Please contact Cara Keslar, Monitoring Section Supervisor, with questions at 307-777-8684.

Sincerely,

Darla J. Potter
Air Quality Resource Program Manager
Wyoming Department of Environmental Quality - Air Quality Division

Cc: Cara Keslar, WDEQ-AQD

EE Initial Notification Summary Information

Ozone Exceedances

Submitting Agency: State Of Wyoming- Air Quality Division
Agency Contact: Cara Keslar
Date Submitted: 1/14/2020
Applicable NAAQS: 2015 ozone – 8-hour 0.070 ppm
Affected Regulatory Decision[1]: F) Case-by-case basis, please see cover letter.
(for classification decisions, specify level of the classification with/without EE concurrence)
Area Name/Designation Status: Attainment/Unclassifiable (Southern Sweetwater and Fremont Counties); Marginal Nonattainment (2008 NAAQS) and Attainment/Unclassifiable (2015 NAAQS) (Sublette and Northern Sweetwater Counties)
Design Value Period (list three year period): 2017-2019
(where there are multiple relevant design value periods, summarize separately)

A) Information specific to each flagged monitor day that may be submitted to EPA in support of the affected regulatory decision listed above

Date of Event	Type of Event (high wind, volcano, wildfires/prescribed fire, other[2])	AQS Flag	Monitor AQS ID (and POC)	Monitor Name	Exceedance Concentration (with units)	Notes (e.g. event name, links to other events)
8/3/2019	Wildfire Smoke	RT	56-037-0300-1	Moxa	0.074 ppm	Wildfire Smoke Event currently under investigation by AQD as a possible Exceptional Event
4/28/2019	SI	RO	56-013-0099-1	South Pass	0.077 ppm	Stratospheric ozone intrusion exceptional event April 28, 2019
4/28/2019	SI	RO	56-035-1002-1	Juel Springs	0.072 ppm	Stratospheric ozone intrusion exceptional event April 28, 2019
4/28/2019	SI	RO	56-035-0700-1	Big Piney	0.074 ppm	Stratospheric ozone intrusion exceptional event April 28, 2019
4/28/2019	SI	RO	56-037-0300-1	Moxa	0.071 ppm	Stratospheric ozone intrusion exceptional event April 28, 2019

B) Violating / Exceeding Monitors Information

(listing of all monitors in the planning area that exceeded due to this Exceptional Event, regardless of operating agency, and regardless of whether or not they are impacted by EEs)

Monitor (AQS ID and POC)	Design Value (without EPA concurrence on any of the events listed in table A above)	Design Value (with EPA concurrence on all events listed in table A above)

South Pass (56-013-0099-1)- 4/28/2019	0.065	0.065
Juel Springs (56-035-1002-1)- 4/28/2019	0.066	0.066
Big Piney (56-035-0700-1)- 4/28/2019	0.063	0.062
Moxa (56-037-0300-1)- 8/3/2018, 4/28/2019	0.066	0.066

[1] designation, classification, attainment determination, attainment date extension, or finding of SIP inadequacy leading to SIP call
[2] Provide additional information for types of event described as "other"

C) Summary of Maximum Design Value (DV) Monitor Information (Effect of EPA Concurrence on Maximum Design Value Monitor Determination)
(Two highest values from Table B)

	Design Value	Design Value Monitor	Comment
Maximum DV monitor (AQS ID and POC) **without EPA concurrence** on any of the events listed in table A above	0.066	South Pass (56-013-0099-1)	
Maximum DV monitor (AQS ID and POC) **with EPA concurrence** on all events listed in table A above	0.066	South Pass (56-013-0099-1)	
Maximum DV monitor (AQS ID and POC) **without EPA concurrence** on any of the events listed in table A above	0.066	Moxa (56-037-0300-1)	
Maximum DV monitor (AQS ID and POC) **with EPA concurrence** on all events listed in table A above	0.066	Moxa (56-037-0300-1)	

D) List of any monitors (AQS ID and POC) within planning area with invalid design values (e.g. due to data incompleteness)

State of Wyoming
Department of Environmental Quality/Air Quality Division

Exceptional Event Demonstration Package for the Environmental Protection Agency

Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming Ozone Standard Exceedances - April 28, 2019

200 W. 17th Street, 3rd Floor, Cheyenne, WY 82002

NOTES TO READER:

All time references refer to Mountain Standard Time (MST) unless otherwise noted. EPA utilizes Mountain Standard Time (MST) consistently throughout the entire year in respect to ambient and ground based meteorological monitoring data collection and reporting. Ozone concentrations appear throughout the document in part per billion (ppb) as well as parts per million (ppm). For example, 70 parts per billion (ppb) is equal to 0.070 part per million (ppm). The Boulder monitoring station's ozone, NOx, and methane/non-methane parameters were not valid during this timeframe due to a calibrator malfunction.

LIST OF ACRONYMS AND TERMS

AMSL	Above Mean Sea-Level
AQI	Air Quality Index
AQS	Air Quality System
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DOE	Department of Energy
DPI	Derived Product Image
DU	Dobson Unit
ECC	Electrochemical Concentration Cell
EDAS	Eta Data Assimilation System
EPA	Environmental Protection Agency
FOV	Field-of-View
GOES	Geostationary Operational Environmental Satellite
HRRR	High-Resolution Rapid Refresh
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
IPV	Isentropic Potential Vorticity
K	Kelvin
KNMI	Koninklijk Nederlands Meteorologisch Instituut
kt	Knot
mb	Millibar
mol/cm^2	Moles per Centimeter Squared
MST	Mountain Standard Time
NAAQS	National Ambient Air Quality Standards
NAM	North American Mesoscale
NARR	North America Regional Reanalysis
NASA	National Aeronautics and Space Administration
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
O_3	Ozone
OMI	Ozone Measuring Instrument
PT	Potential Temperature
PVU	Potential Vorticity Unit
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
RAOB	Radiosonde Observation
RAP	Rapid Refresh
RAQMS	Realtime Air Quality Modeling System
RH	Relative Humidity
SI	Stratospheric Intrusion
SO_2	Sulfur Dioxide
SSEC	Space Science and Engineering Center
STP	Standard Temperature and Pressure
TCO	Total Column Ozone

UGRB	Upper Green River Basin
UV	Ultraviolet
VOC	Volatile Organic Compound
WDEQ/AQD	Wyoming Department of Environmental Quality/Air Quality Division

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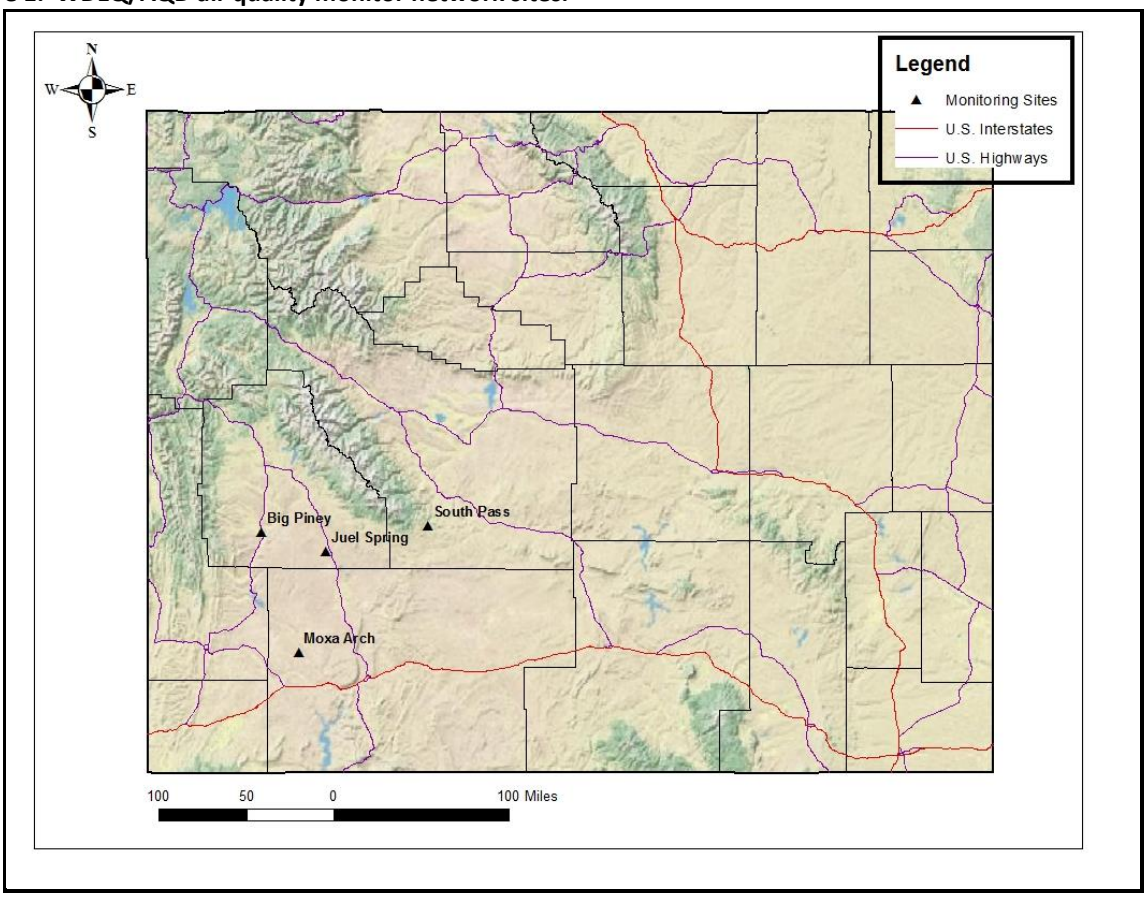
CONCEPTUAL MODEL

The Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD) has determined that a stratospheric intrusion created elevated ozone readings resulting in 8-hour ozone standard exceedances at the Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming ozone monitors located in and near the Upper Green River Basin (UGRB) of western Wyoming on April 28, 2019 (refer to Fig. 1 for monitor locations).

Figure 1. WDEQ/AQD air quality monitor network sites.

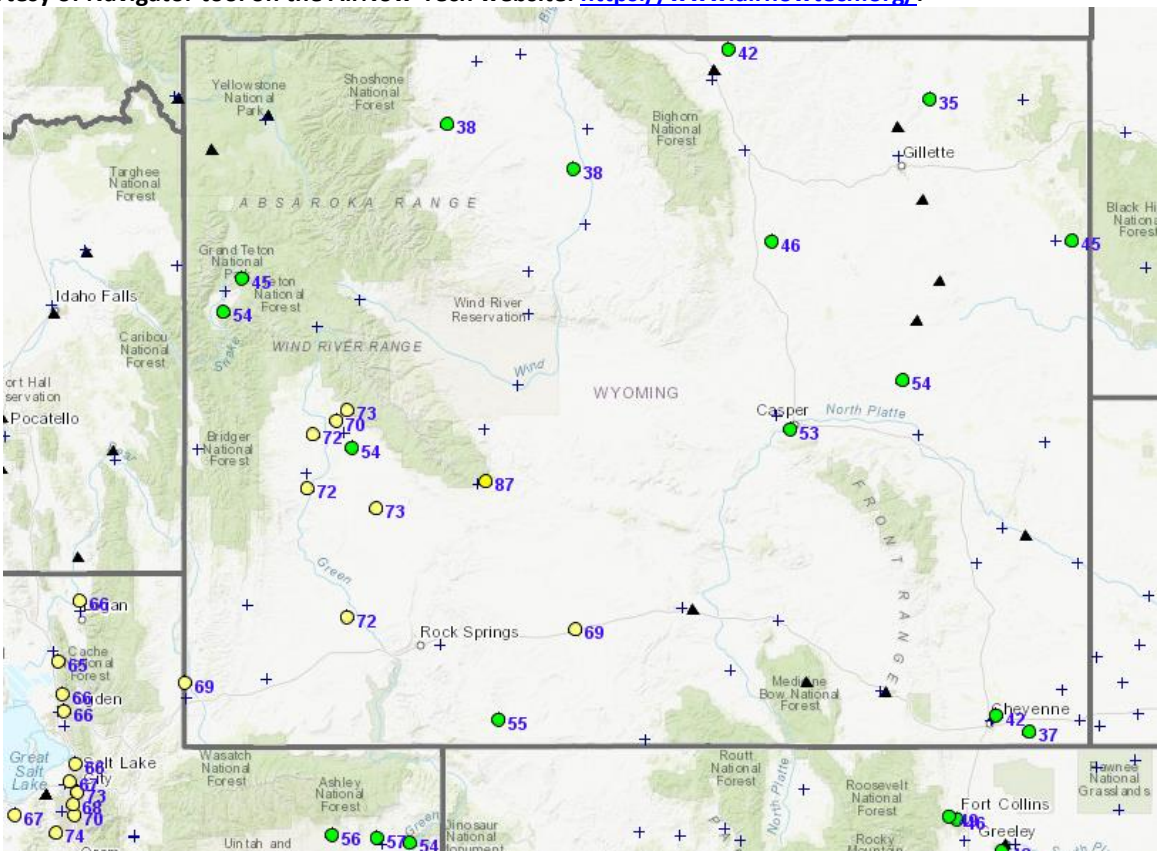


During the interval from late winter to late spring in the northern hemisphere, weather producing systems (i.e. tropospheric storm systems, upper level disturbances or upper level storm systems) aid in causing the tropopause to "fold" or descend into the troposphere where our weather occurs. Tropopause folding allows ozone-rich air from the stratosphere to enter the troposphere, also called a stratospheric intrusion (SI), creating the potential for ground level ozone monitors over the higher terrain of the western United States to experience elevated readings.

Throughout April 28, 2019, an upper level atmospheric disturbance with an associated SI moved over central Idaho injecting ozone-rich air into the troposphere. The ozone-laden air then moved over western Wyoming creating elevated ozone readings resulting in exceedances of the 2015 8-hour ozone National Ambient Air Quality Standard (NAAQS) of 74, 72, 71, and 77 ppb at the Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming ozone monitors, respectively.

Additionally, several ozone monitors in northeast Utah and western Wyoming showed elevated 8-hour ozone values. Elevated 1-hour average ozone values from the low 60s to upper 60s ppb during the SI event were present in northeast Utah and southwest Wyoming (refer to Fig. 2). (Note to reader: The Boulder monitoring station's ozone, NOx and methane/non-methane parameters were not valid due to a calibrator malfunction).

Figure 2. 1-hour average ozone data for Wyoming ozone monitors for 4 PM MST on April 28, 2019. Image courtesy of Navigator tool on the AirNow-Tech website: https://www.airnowtech.org/.



It has been documented (T. S. ENVIRON 2008) that elevated ozone values can occur at the UGRB ozone monitors of Boulder, Big Piney, Pinedale, Daniel, and Juel Springs because of light winds, snow cover, and strong inversions during the January-March winter ozone season. However, during the April 28, 2019 period of elevated ozone, strong winds buffeted the UGRB prior to the SI event, and no snow cover or strong inversions were present. Accumulation of surface-based ozone precursors did not occur because meteorological conditions were not supportive of precursor buildup prior to elevated ozone readings.

The comparison to historical data performed on the Big Piney, Juel Springs, Moxa Arch, and South Pass data show that the April 28, 2019 ozone data was statistically significantly higher than values recorded during April of each year from 2011-2019 (Big Piney), 2010-2019 (Juel Springs), 2011-2019 (Moxa Arch), and 2007-2019 (South Pass). The WDEQ/AQD thoroughly evaluated the April 28, 2019 episode, and is confident that the Big Piney, Juel Springs, Moxa Arch, and South Pass event presented in this document is the result of a SI.

Quality Assurance/Quality Control (QA/QC) checks of the Big Piney, Juel Springs, Moxa Arch, and South Pass ozone monitors during 2019 confirm that the monitors were operating properly. Again, the Boulder monitoring station's ozone, NOx, and methane/non-methane parameters were not valid during this timeframe due to a calibrator malfunction.

With the preceding points in mind, the WDEQ/AQD submits the April 28, 2019 Big Piney, Juel Springs, Moxa Arch, and South Pass ozone exceedances as a case for the Environmental Protection Agency's (EPA) concurrence regarding the stratospheric intrusion of ozone as being an exceptional event. Per 40 CFR 50.1(j), the three core statutory elements that define an exceptional event are a clear causal relationship between the specific event and the monitored exceedance, the event was not reasonably controllable or preventable, and the event was caused by human activity unlikely to recur at a particular location or was a natural event. The WDEQ/AQD presents evidence that clearly shows that this event meets these criteria in addition to the elements required to justify data exclusion as identified in A-E of 40 CFR 50.14 (c)(3)(iv):

(A) A description of the event and how it led to exceedances at the monitors;
(B) A demonstration of a clear causal relationship between the event and violation;
(C) An analysis comparing the data influenced by the event to data from the same monitor at different times;
(D) A demonstration that the event was not controllable or preventable; and
(E) A demonstration that the event was a human activity unlikely to recur or a natural event.

Criteria **(A)** is "[a] narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s)":

> The narrative provided in the *Description of the Event and How It Led to Exceedances at the Monitors* section of this demonstration explains the stratospheric intrusion that caused the exceedances at Big Piney, Juel Springs, Moxa Arch, and South Pass.

Criteria **(B)** is a "[d]emonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation":

> The documentation provided in the *Demonstration of a Clear Causal Relationship Between the Event and Violation* section of this demonstration show that the subject stratospheric intrusion caused each of the identified exceedances.

Criteria **(C)** is an "[a]nalysis comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times…":

> The analysis provided in the *Analysis Comparing the Data Influenced by the Event to Data from the Same Monitor at Different Times* section of this demonstration clearly shows that the exceptional event was statistically significantly higher than data recorded during prior months of April since each monitoring station came online.

Criteria **(D)** is a "[d]emonstration that the event was both not reasonably controllable and not reasonably preventable":

> The documentation provided in the *Demonstration of a Clear Causal Relationship Between the Event and Violation* section in this demonstration show that the subject stratospheric intrusion caused each of the identified exceedances. Through these analyses and the fact that stratospheric intrusions are purely natural events that cannot be prevented or controlled, WDEQ/AQD has satisfied the 'not reasonably controllable or preventable' criterion.

Criteria **(E)** is "[a] demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event":

> The Exceptional Events Rule states that a '[n]atural event, which may recur, is one in which human activity plays little or no direct causal role.' Therefore, stratospheric intrusions that cause monitored ambient ozone exceedances or violations are considered to be natural exceptional events. The WDEQ/AQD has shown through the analyses provided in the *Demonstration of a Clear Causal Relationship Between the Event and Violation* section of this demonstration that the subject stratospheric intrusion caused each of the identified exceedances. Through these analyses and the fact that stratospheric intrusions are purely natural, the WDEQ/AQD has satisfied the 'human activity that is unlikely to recur at a particular location or a natural event' element of 40 CFR 50.14(c)(3).

In brief, the WDEQ/AQD concludes that an SI occurred during April 28, 2019 resulting in an exceptional event. This exceptional event has passed the four criterion tests under 40 CFR 50.14 (3)(iii). Consequently, the WDEQ/AQD is requesting EPA's concurrence that the event was exceptional and for the exclusion from the Air Quality System (AQS) database of the Big Piney, Juel Springs, Moxa Arch, and South Pass 1-hour average ozone data for the following times in Table 1:

Table 1. Big Piney, Juel Springs, Moxa Arch, and South Pass times and dates for AQS data exclusion.

Site	AQS ID	Begin Time/Date(s)	End Time/Date(s)
Big Piney	56-035-0700	0000 MST April 28, 2019	2400 MST April 28, 2019
Juel Springs	56-035-1002	0000 MST April 28, 2019	2400 MST April 28, 2019
Moxa Arch	56-037-0300	0000 MST April 28, 2019	2400 MST April 28, 2019
South Pass	56-013-0099	0000 MST April 28, 2019	2400 MST April 28, 2019

BACKGROUND

Document Format

The following discussion provides background information on SIs as well as the methodology utilized in identifying SIs. Subsequently, the April 28, 2019 event is presented with evidence supporting the premise that an SI occurred creating a period of elevated 1-hour average ozone values resulting in ozone standard exceedances at the Big Piney, Juel Springs, Moxa Arch, and South Pass ozone monitors.

Ground Level Ozone Formation

"Ozone (O_3) is a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground level is created by a chemical reaction between oxides of nitrogen (NOx) [including nitrogen dioxide (NO_2)] and volatile organic compounds (VOCs) in the presence of sunlight. Ozone has the same chemical structure whether it occurs miles above the earth or at ground level and can be "good" or "bad," depending on its location in the atmosphere." (Source: EPA website). Specifically, NO_2 is split by ultraviolet (UV) sunlight to give nitric oxide (NO) and an oxygen atom, which combines with molecular oxygen (O_2) to give ozone. Calm winds, or stagnant conditions assist the process of allowing the O_3 precursors of NO_x (NO_2) and VOCs to accumulate in order to produce O_3. Unlike ozone of stratospheric origin, ground-based ozone typically forms during the daylight hours under stagnant weather conditions (over several days in some cases) and dissipates a few hours after sunset.

Atmospheric Structure

The troposphere is the layer of air adjacent to the earth's surface and contains our weather (i.e. wind, rain, snow, thunderstorms, etc.) The troposphere also contains variable amounts of water vapor and carbon monoxide (CO), extends to a height of roughly 11 km (6.8 mi) Above Mean Sea-level (AMSL), and varies in depth from the earth's polar regions to the equator. Directly above the troposphere, the stratosphere exists with the tropopause separating the stratosphere from the troposphere. The tropopause is "...usually characterized by an abrupt change of lapse rate[1]" (American Meteorological Society 2010).

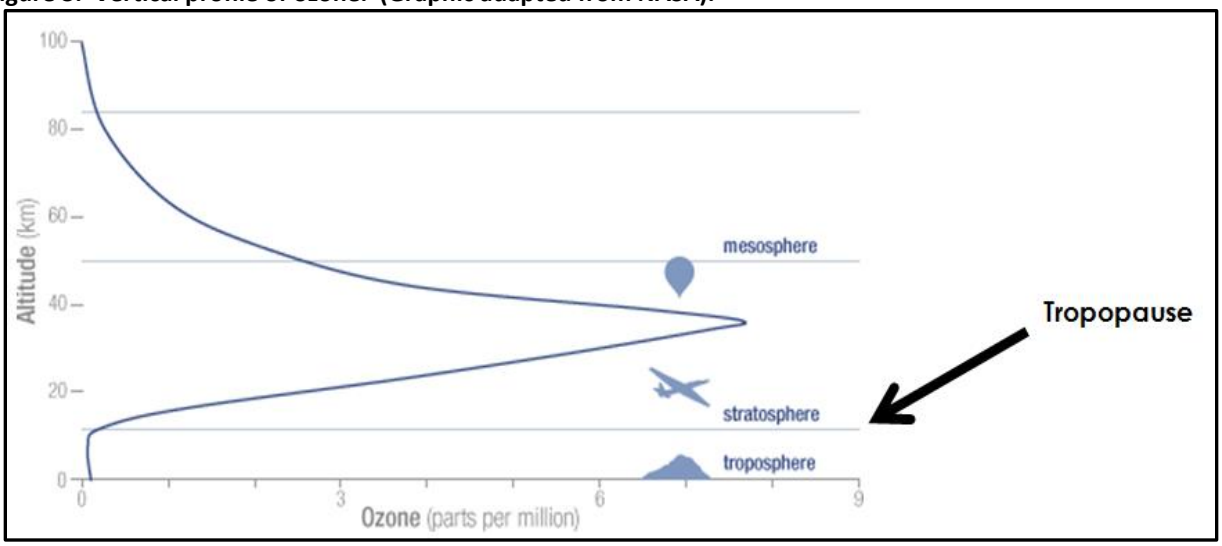
The stratosphere is the "...region of the atmosphere extending from the top of the troposphere [the tropopause], at heights of roughly 10–17 km...[and] is characterized by constant or increasing temperatures with increasing height and marked vertical stability" (American Meteorological Society 2010).

Composition of Stratospheric Air

"While the major constituents of the stratosphere are molecular nitrogen and oxygen, just as in the troposphere, the stratosphere contains a number of minor chemical species that result from photochemical reactions in the intense ultraviolet radiation environment. Chief among these is ozone..." (American Meteorological Society 2010). While the troposphere contains variable amounts of O_3, CO, and water vapor, the stratosphere lacks CO and water vapor (Pan, Randel, et al. 2004; Newell, et al. 1999; Stoller, et al. 1999). Figure 3 demonstrates the typical concentration of ozone with height extending from the earth's surface through the stratosphere.

[1] Lapse rate is defined as the change of temperature with the increase of height in the atmosphere.

Figure 3. Vertical profile of ozone. (Graphic adapted from NASA).



Stratospheric Intrusions, Tropospheric Folding, and Identifying Stratospheric Air

Weather producing systems (i.e. tropospheric storm systems, upper level disturbances or upper level storm systems) contain atmospheric spin or vorticity, which induces vertical motion: either upward or downward motion. From late winter to late spring in the northern hemisphere, vertical motion associated with upper level disturbances aids in causing the tropopause to "fold" or descend into the troposphere where our weather occurs (Danielsen 1968). Because of tropopause folding, an intrusion of stratospheric air containing high concentrations of ozone penetrates into the troposphere (Reed 1955) releasing ozone-rich air from the stratosphere to the troposphere. As a result, the SI creates the potential for ground level ozone monitors over the higher terrain of the western United States to experience elevated ozone readings.

SIs are a tangible phenomenon. One study analyzed over 105,000 aircraft soundings, and discovered that just over 50% of the soundings contained regions of high ozone and low water vapor content occurring below the tropopause (Newell, et al. 1999). The presence of areas of high ozone concentrations and low water vapor located below the tropopause are components of an SI signature.

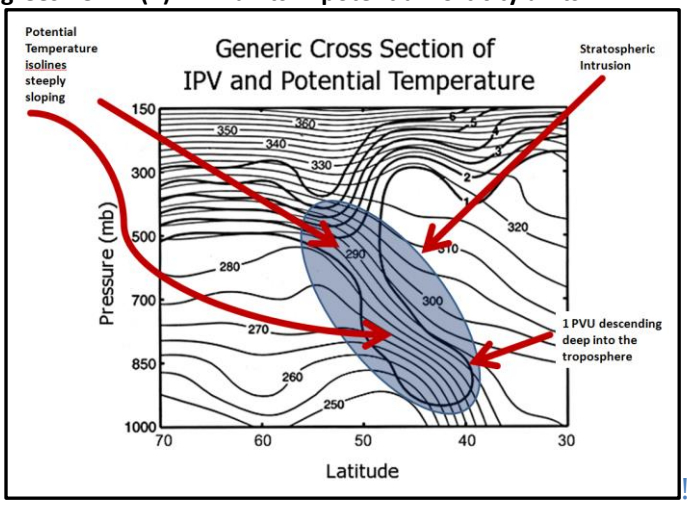
While the concentrations of O_3, CO, and relative humidity (RH) aid one in identifying air of stratospheric origin, additional stratospheric tracers[2] should be employed and include: isentropic potential vorticity (IPV) and potential temperature (PT). IPV is a proxy for atmospheric spin and is a conservative property[3] with values of up to two orders of magnitude [100 times] greater for stratospheric air than that of tropospheric air (Shapiro 1980). Therefore, IPV can serve as a tracer of stratospheric air. One unit of IPV (1-PVU)[4] typically represents the tropopause

[2] "A chemical or thermodynamic property of the flow that is conserved during" air motion (American Meteorological Society 2010).
[3] "A property with values that do not change in the course of a particular series of events" (American Meteorological Society 2010). Namely, a property whose values do not change over the course of travel.
[4] IPV and PVU are utilized throughout this document and are synonymous. For further information, please consult: http://www.comet.ucar.edu/class/aes_canada/04-1/html/docs/PVintro.pdf

(Shapiro 1980), and as one ascends beyond the tropopause into the stratosphere, the value of IPV increases correspondingly. However, within the last decade a study by Pan revealed that using only IPV to define the tropopause is problematic. In fact, the thermal tropopause height "...spans a broad range of..." IPV values and varies latitudinally and seasonally (Pan 2004). Therefore, based on the WDEQ/AQD's review of the background material regarding IPV usage, the WDEQ/AQD recognizes that one cannot use IPV alone in identifying air of stratospheric origin.

Potential temperature is "the temperature that an unsaturated parcel of dry air would have if brought adiabatically[5] and reversibly from its initial state to a standard pressure, p0, typically 100 kPa" (or 1000 mb) (American Meteorological Society 2010). Stratospheric air has much higher values of potential temperature than that of tropospheric air. As stratospheric air penetrates the troposphere, its potential temperature is higher than that of tropospheric air surrounding the SI. One can visualize this effect by cross-section examination of IPV and PT. The slope of isolines[6] of potential temperature increase markedly showing this effect (Reed 1955). Figure 4 shows a generic vertical cross-section of IPV and PT. Note the area of sloping isolines of PT and the 1-PVU surface juxtaposed on one another. The slope of the isolines of PT increases significantly highlighting the signature of stratospheric air descending into the troposphere.

Figure 4. Vertical cross-section of potential temperature (thin solid lines) and IPV (thick solid lines). Potential temperature units are degrees Kelvin (K). IPV units in potential vorticity units.



[5] "Adiabatic process—A process in which a system does not interact with its surroundings by virtue of a temperature difference between them. In an adiabatic process, any change in internal energy (for a system of fixed mass) is solely a consequence of working. For an ideal gas and for most atmospheric systems, compression results in warming, expansion results in cooling" (American Meteorological Society 2010). Compression and expansion arise from downward atmospheric vertical motion and atmospheric upward vertical motion respectively.

[6] "... a line of equal or constant value of a given quantity, with respect to either space or time…" (American Meteorological Society 2010)

Background Summary

The stratosphere contains high concentrations of ozone compared to the troposphere. At times, from late winter until late spring in the northern hemisphere, tropospheric storm systems act synergistically with tropopause folds to inject stratospheric ozone into the troposphere via an SI. Compared to tropospheric air, stratospheric air is typically much drier, has higher values of IPV and PT, and contains lower quantities of CO.

Data from research aircraft have determined that tropopause folds (SIs) contain ample O_3, dry air, and low concentrations of CO. Mathematical calculations based on the aircraft data also verify that the SIs had greater than 1-PVU and had higher PT values compared to those of the troposphere surrounding the SI.

METHODOLOGY FOR DIAGNOSING SI EVENTS

Since the majority of SIs occur from the late winter to late spring (Danielsen 1968), elevated ozone episodes occurring during this time merit further analysis. The WDEQ/AQD recognizes that a combination of indicators should be employed when diagnosing an SI. One should not rely on any single indicator alone. The following offers a methodology to diagnose whether an SI has occurred:

- Summary of the synoptic scale meteorology

  An examination of the 500 mb heights and vorticity chart may indicate an SI if an upper level atmospheric disturbance occurred at some point before ground level ozone values increased. By inspecting the 500 mb pressure chart by way of the North America Regional Reanalysis (NARR)[7], one can establish whether an upper atmospheric disturbance took place.

- Employ Geostationary Operational Environmental Satellite (GOES) data

  "GOES satellites provide the kind of continuous monitoring necessary for intensive data analysis. They circle the Earth in a geosynchronous orbit, which means they orbit the equatorial plane of the Earth at a speed matching the Earth's rotation. This allows them to hover continuously over one position above the Earth's surface. The geosynchronous plane is about 35,800 km (22,300 miles) above the Earth, high enough to allow the satellites a full-disc view of the Earth....the main mission [of GOES satellites] is carried out by the primary instruments, the imager and the sounder. The imager is a multichannel instrument that senses radiant energy and reflected solar energy from the Earth's surface and atmosphere. The Sounder provides data to determine the vertical temperature and moisture profile of the atmosphere, surface and cloud top temperatures, and ozone distribution." (Source: NOAA Satellite and Information Service, National Environmental Satellite, Data, and Information Service, Office of Satellite Operations website).

  Recent studies and research have shown that usage of GOES data is a useful tool in diagnosing SIs (Jin, et al. 2008). One can use the GOES total column ozone [8]data in

[7] "The North America Regional Reanalysis (NARR) Project is a reanalysis of historical observations using a 32-km version of the National Centers for Environmental Prediction (NCEP) 1993 operational ETA model and ETA data assimilation system (EDAS)....The domain of analyses includes North and Central America...The period of the reanalyses is from October 1978 to the present and analyses were made 8 times daily (3 hour intervals). Horizontal boundary conditions are derived from the NCEP/DOE Global Reanalysis." For further information, please refer to visit this website: http://www.esrl.noaa.gov/psd/data/gridded/data.narr.html

[8] Total column ozone (TCO) is estimated every hour using GOES Sounder data. The ozone retrieval is generated by application of a regression technique as described in Li et al 2007. Estimates are currently limited to cloud-free regions of the GOES-E (12) & -W (11) Sounder sectors. Each image is a Derived Product Image (DPI), wherein an 8-bit brightness value representing TCO is assigned within the retrieval program for each cloud-free Field-of-View (FOV). Band-8 (11.0um) is used for the DPI image background. Total column ozone is measured in Dobson Units (100 DU = 1 mm of thickness at Standard Temperature and Pressure (STP)). Features such as upper level low-pressure systems and frontal boundaries can often be identified in the TCO imagery. (Source: Data Center at the Space Science and Engineering Center (SSEC) of the University of Wisconsin – Madison)

Dobson Units (DU)[9] to locate areas of increased column ozone (Wimmers, et al. 2003; Knox and Schmidt 2005). Numerous studies have shown a positive correlation between an SI and an increase in the total column ozone. As the SI injects ozone into the troposphere, total column ozone increases (Reed 1950; Schubert and Munteanu 1988; Mote, Holton and Wallace 1991).

The GOES Band-12 channel is a water vapor channel that portrays the moisture content of the layer approximating 300-400 mb (Wimmers, et al. 2003). Use of the water vapor image helps highlight an area of substantially drier air originating from aloft mixing down to lower levels of the troposphere. Since SIs contain dry air and transverse through the 300-400 mb tropospheric layer, one can use the 6.5-micrometer GOES Band-12 water vapor channel to diagnose the presence of an SI signature.

- Employ Radiosonde observations

  Another way to diagnose the existence of stratospheric air is by examining Radiosonde observations (RAOBs). RAOBs are comprised of three elements: a radiosonde (an instrument that measures and transmits pressure, relative humidity, and temperature data to a ground receiver), a parachute, and a balloon. The balloon is released into the sky carrying the radiosonde and parachute. A layer of dry air is a key signature of stratospheric air (as measured by a radiosonde) and is depicted by an increase in temperature and a decrease in dew point (moisture) with height (Newell, et al. 1999; Stoller, et al. 1999).

  When coupled with a radiosonde, an ozonesonde provides direct evidence of the vertical profile of ozone concentration. An ozonesonde contains an electrochemical concentration cell (ECC) that senses ozone as it reacts with a dilute solution of potassium iodide to produce a weak electrical current proportional to the ozone concentration (partial pressure) of the sampled air.

- Employ 4-D "0-hour" Rapid Refresh (RAP) data (IPV, RH, and PT)

  The RAP is a numerical weather analysis tool utilized by meteorologists to predict weather conditions. The RAP is initialized with real-time data, and the 0-hour analysis for any given hour is a very close approximation to initial actual conditions (Benjamin, et al. 2004). RAP "analysis" data can be used to illustrate the signature of an SI (refer to Figure 4) by portraying IPV, RH, and PT (Murray 2003) via a vertical cross-section or a time-height cross-section of the atmosphere.

[9] The Dobson Unit is the most common unit for measuring ozone concentration. One Dobson Unit is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 0 degrees Celsius and a pressure of 1 atmosphere (the air pressure at the surface of the Earth). Expressed another way, a column of air with an ozone concentration of 1 Dobson Unit would contain about 2.69x1016 ozone molecules for every square centimeter of area at the base of the column. Over the Earth's surface, the ozone layer's average thickness is about 300 Dobson Units or a layer that is 3 millimeters thick.

- Perform trajectory analysis

  A means of tracking the path of air parcels is by employing backward and forward trajectories to demonstrate the origins of "pockets" of high ozone due to SIs. One can use the HYSPLIT software package (Draxler and Rolph n.d.) to demonstrate not only the origin of air parcels, but also the evolution of air parcels as they move through the troposphere. By selecting a range of altitudes and times at a specific location, one can use HYSPLIT to analyze the path air parcels took prior to arriving at a selected point (backward trajectories). Conversely, one can employ the same analysis technique to determine the eventual fate of air parcels originating from a specific point (forward trajectories). In the case of SIs, trajectory analysis is used to show how "pockets" of air containing high ozone concentrations arrived at monitors which indicated elevated ozone levels (Sørensen and Nielsen 2001; Aulerio, et al. 2005).

SUMMARY OF DIAGNOSING SI EVENTS

To review, the key features of a SI event are:

- An upper level disturbance producing a tropospheric fold and subsequent SI.
- Depicted in cross-sections or time-height cross-sections by sloping lines of PT, by 1-PVU or greater descending into the troposphere, and by an area of dry air.
- A well-mixed or even turbulent atmosphere resulting from an upper level disturbance and creating conditions for vertical movement of SI-air to the earth's surface.

Additionally, WDEQ/AQD is a member of a national EPA SI workgroup that was formed during 2012. The primary goal of the workgroup is to diagnose past SI events, including the April 28, 2019 event described in this document. This specific SI event was discussed thoroughly on May 28, 2019 and June 13, 2019 phone calls with EPA Region 8 and the EPA SI workgroup. Attendees agreed that evidence presented indicated an SI event had occurred.

DESCRIPTION OF THE EVENT AND HOW IT LED TO EXCEEDANCES AT THE MONITORS

On April 28, 2019, an upper level atmospheric disturbance associated with an SI moved over central Idaho injecting ozone-rich air into the troposphere. The ozone-laden air then moved over western Wyoming creating elevated ozone readings resulting in 8-hour ozone standard exceedances of 74, 72, 71, and 77 ppb at the Big Piney, Juel Springs, Moxa Arch, and South Pass Wyoming ozone monitors, respectively.

Additionally, ozone monitors northwest of the Wind River Range as well as monitors in northeast Utah measured elevated 1-hour average ozone values from the upper 60s to low 70s ppb during the SI event as early as 9 AM MST (refer to Figure 5). (Note to reader: The Boulder monitoring station's ozone, NOx, and methane/non-methane parameters were not valid during this timeframe due to a calibrator malfunction).

Furthermore, EPA's April 28, 2019 daily peak ozone air quality index (AQI) map illustrates the effects of the SI over Idaho, northeast Utah, and western Wyoming (Figure 6). Southeastern Idaho, northern Utah, and western Wyoming were either in the "moderate" category (yellow shade) or "unhealthy for sensitive groups" category (orange shade).

It has been documented (T. S. ENVIRON 2008) that elevated ozone values can occur at the UGRB ozone monitors of Boulder, Big Piney, Pinedale, Daniel, and Juel Springs because of anthropogenic emissions coupled with light winds, snow cover, and strong inversions during the January-March winter ozone season. However, during the April 28, 2019 period of elevated ozone, strong winds buffeted the UGRB prior to the SI event; there was no snow cover and strong inversions were not present. Accumulation of surface-based ozone precursors did not occur because meteorological conditions were not supportive of precursor buildup prior to elevated ozone readings.

For the month of April from 2006 to 2019, Wyoming ground level, 1-hour average ozone levels at the Big Piney, Juel Springs, Moxa Arch, and South Pass ozone monitors ranged from 38-51 ppb (25-75% interquartile range) with a mean of 44 ppb. However, when an SI occurs, 8-hour average values (derived from the 1-hour average) can exceed 80 ppb on a time scale of a few hours to a few days (Mohnen and Reiter 1977). While not exceeding 80 ppb, 8-hour average ozone greater than 70 ppb occurred at the Big Piney, Juel Springs, Moxa Arch, and South Pass stations on April 28, 2019. At 12 and 1 pm MST on April 28, 2019, the Big Piney ozone monitor recorded the highest 1-hour average ozone value of 81 ppb resulting in a daily maximum rolling 8-hour average of 74 ppb. At 1 pm MST on April 28, 2019, the Juel Springs ozone monitor recorded the highest 1-hour average ozone value of 76 ppb resulting in a daily maximum rolling 8-hour average of 72 ppb. At 5 pm MST on April 28, 2019, the Moxa Arch and South Pass ozone monitors recorded the highest 1-hour average ozone values of 79 ppb and 92 ppb, respectively, resulting in daily maximum rolling 8-hour averages of 71 ppb and 77 ppb, respectively.

Public Notification and EPA's Air Quality System Data

WDEQ/AQD's Wyoming Visibility Monitoring Network (WyVisNet) website provided near real-time pollutant and meteorological data from all WDEQ/AQD gaseous stations and was operational during the April 28, 2019 elevated ozone event. Citizens of Wyoming have continuous access to WyVisNet via the Internet, which serves as a means of public information dissemination regarding elevated ozone readings. Additionally, data from all four locations, Big Piney, Juel Springs, Moxa Arch, and South Pass, are reported to the EPA's AIRNow website.

The public also has access to EPA's AQS database that houses validated data from the WDEQ/AQD's monitoring stations. Figure 5 shows a time-series of 1-hour average ozone values from AQS during April 28, 2019 for the sites with exceedances. Figure 6 displays the spatial coverage map of 1-hour ozone concentrations that were already elevated by 9 PM MST on April 28, 2019.

Figure 5. Measured 1-hour ozone values on April 28, 2019.

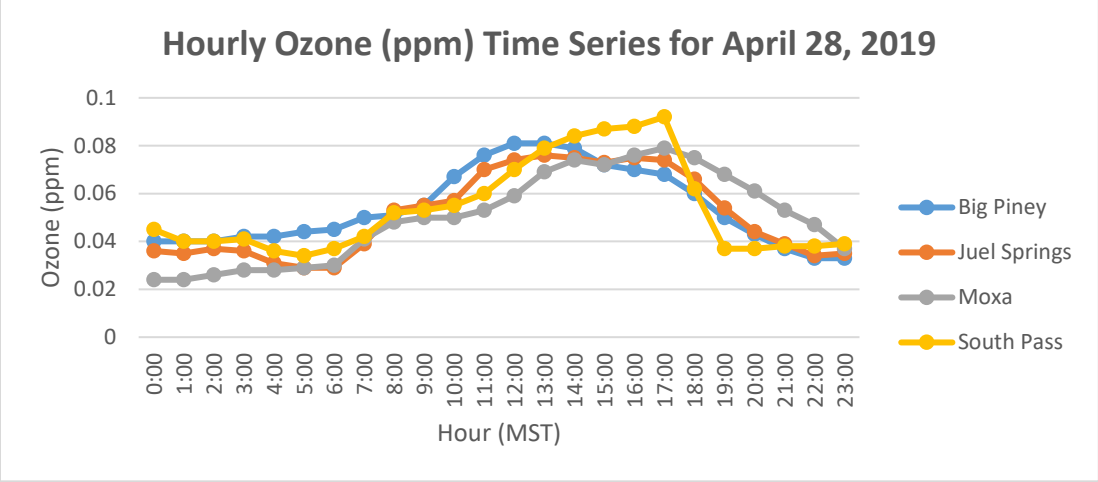
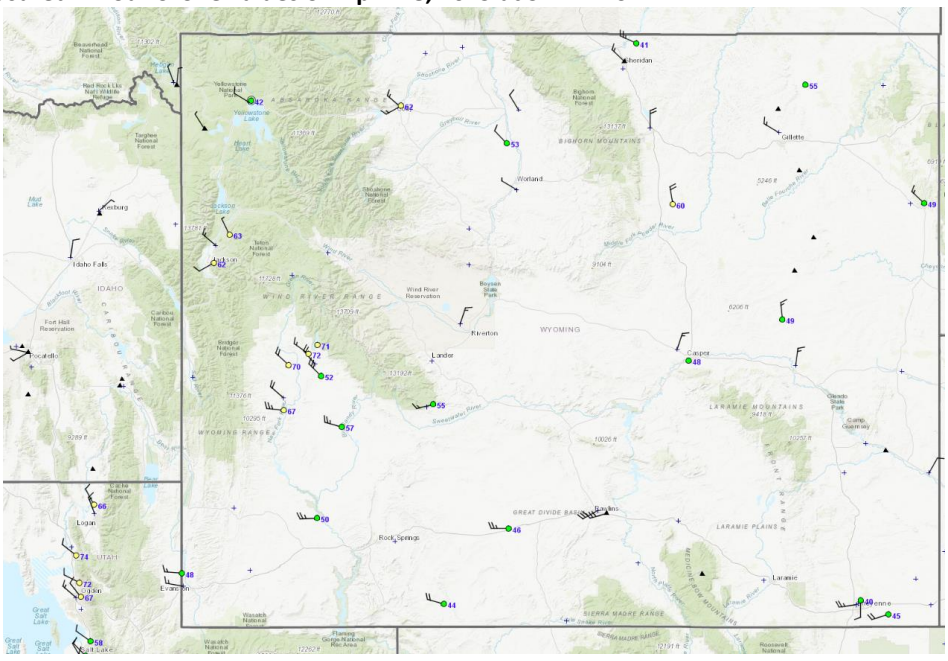
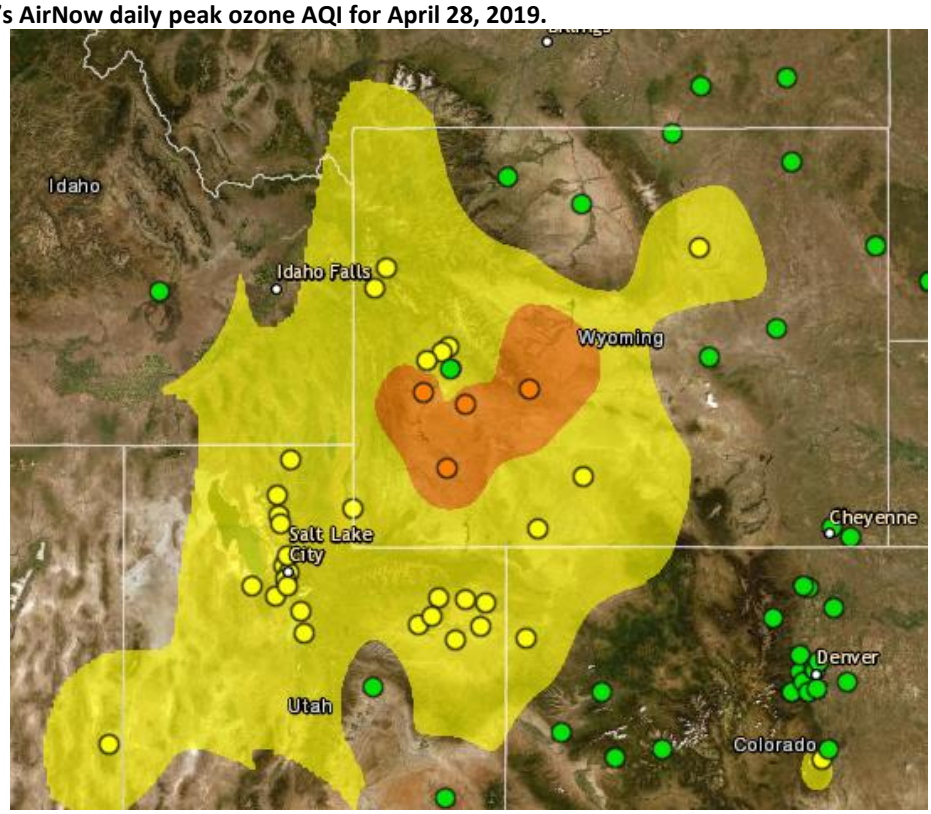


Figure 6. Measured 1-hour ozone values on April 28, 2019 at 9 AM MST.



In Fig. 7, the Air Quality Index (AQI) is shown for April 28, 2019 with areas in orange showing higher values of the AQI near the UGRB. Again, Boulder monitoring data was not valid for this time period.

Figure 7. EPA's AirNow daily peak ozone AQI for April 28, 2019.



Data QA/QC and Equipment

Quality Assurance/Quality Control procedures were followed in accordance with the *Quality Assurance Project Plans* for Big Piney, Juel Springs, Moxa Arch, and South Pass monitoring projects and 40 CFR Part 58, Appendix A, Section 3 *Measurement Quality Check Requirements.* In agreement with Section 3.1.1 *One-Point Quality Control (QC) Checks*, automated checks were completed on the ozone monitors at least every 2 weeks. Additionally, annual performance evaluations (i.e. audits) were conducted according to procedures stated in 40 CFR Part 58 Appendix A Section 3.1.2 *Annual performance evaluation for SO_2, NO_2, O_3, or CO* at the four monitoring sites. During the second quarter of 2019, audits were conducted at Big Piney, Juel Springs, and Moxa Arch. Audits were conducted at South Pass on April 19, 2018 and October 8, 2019. An audit was not performed on South Pass during the second quarter of 2019 because of inability to access the site due to extensive snow cover. Table 2 shows results for these audits, including the audit levels consistent with requirement of 40 CFR Part 58 Appendix A Section 3.1.2. Please note, the audit levels are determined by the individual monitoring station's operating range and high concentrations. All tests met WDEQ/AQD specified data quality objectives, which are consistent with QA Handbook Vol II, Section 3.0, Revision No: 1.

Table 2. Audit statistics for Big Piney, Juel Springs, Moxa Arch, and South Pass.

Big Piney Ozone Audit Results				
Date	**Slope**	**Correlation**	**Y-Intercept**	**Audit Point % Difference**
June 18, 2019	0.890	0.9998	0.002	**Level 2=8.3%** **Level 3=0.0%** **Level 4=-8.1%**
Juel Springs Ozone Audit Results				
Date	**Slope**	**Correlation**	**Y-Intercept**	**Audit Point % Difference**
June 17, 2019	0.914	0.9999	0.002	**Level 2=0.0%** **Level 3=-5.9%** **Level 5=-6.3%**
Moxa Arch Ozone Audit Results				
Date	**Slope**	**Correlation**	**Y-Intercept**	**Audit Point % Difference**
June 17, 2019	0.986	0.9999	0.000	**Level 2=0.0%** **Level 3=-3.3%** **Level 5=-1.3%**
South Pass Ozone Audit Results				
Date	**Slope**	**Correlation**	**Y-Intercept**	**Audit Point % Difference**
April 19, 2018	0.982	0.999	0.001	**Level 2=5.6%** **Level 3=0.0%** **Level 4=-1.3%**
October 8, 2019	0.970	1.0000	0.000	**Level 2=0.0%** **Level 3=-2.7%** **Level 4=-2.8%**

Analysis Comparing the Data Influenced by the Event to Data from the Same Monitor at Different Times

The WDEQ/AQD prepared an analysis showing how the observed event concentrations compared to the distribution and time series of historical concentrations measured at the monitors. Table 3 contains a summary of the ozone at sample sites on April 28, 2019 and how the data compare to historical values at these locations. As can be seen in Table 3, April 28, 2019 ranks as the number one highest 8-hour ozone concentration for Big Piney and South Pass relative to the time period of 2014-2019. For Juel Springs and Moxa Arch, the April 28, 2019 event ranked as the third and sixth highest 8-hour ozone concentration, respectively. All April 28, 2019 monitoring site 8-hour max samples were in the 99th percentile or greater.

Table 3. Tabular summary of event-influenced ozone data in parts per billion (ppb) relative to historical concentrations.

Statistic	Big Piney	Juel Springs	Moxa Arch	South Pass
Data Years	2014-19	2014-19	2014-19	2014-19
Number of 8-hr Max Samples	2031	2037	1981	2002
April 28, 2019 Max 8-hr Ozone (ppb)	74	72	71	77
April 28, 2019 Rank	1 of 2031	3 of 2037	6 of 1981	1 of 2002
April 28, 2019 Percentile	100th	99.9th	99.7th	100th
Mean April Daily Max 8-hr Ozone (ppb)	46.7	48.2	48.7	49.5
Max April Daily Max 8-hr Ozone (ppb)	74	72	71	77
Standard Deviation of April Daily Max 8-hr Ozone (ppb)	7.1	6.9	6.3	7.5

Figures 8-11 display all the maximum 8-hour ozone concentrations from the time each monitoring site came online to end of 2019. Red diamonds indicate SI events (including April 28, 2019) and the 0.070 ppm ozone standard is displayed as a solid orange line. The SI events are clearly outliers on each plot.

Figure 8. Historical comparison scatter plot for Big Piney daily 8-hour maximum ozone. SI events are indicated by red diamonds.

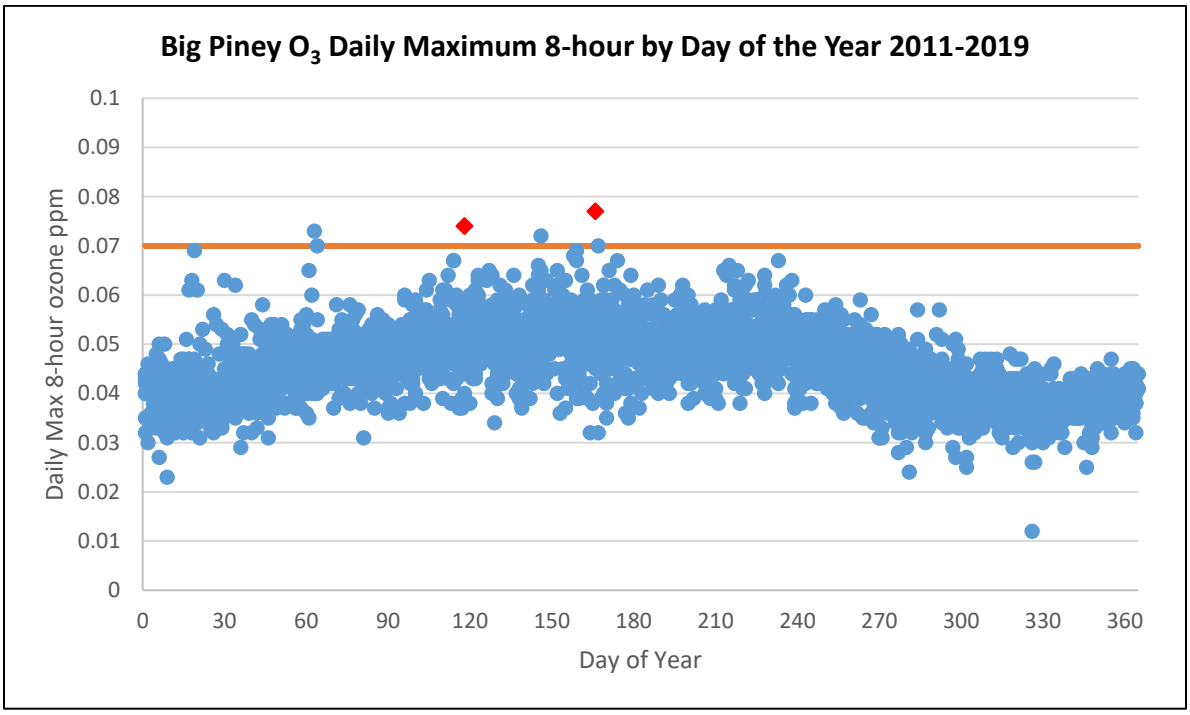


Figure 9. Historical comparison scatter plot for Juel Springs daily 8-hour maximum ozone. SI events are indicated by red diamonds.

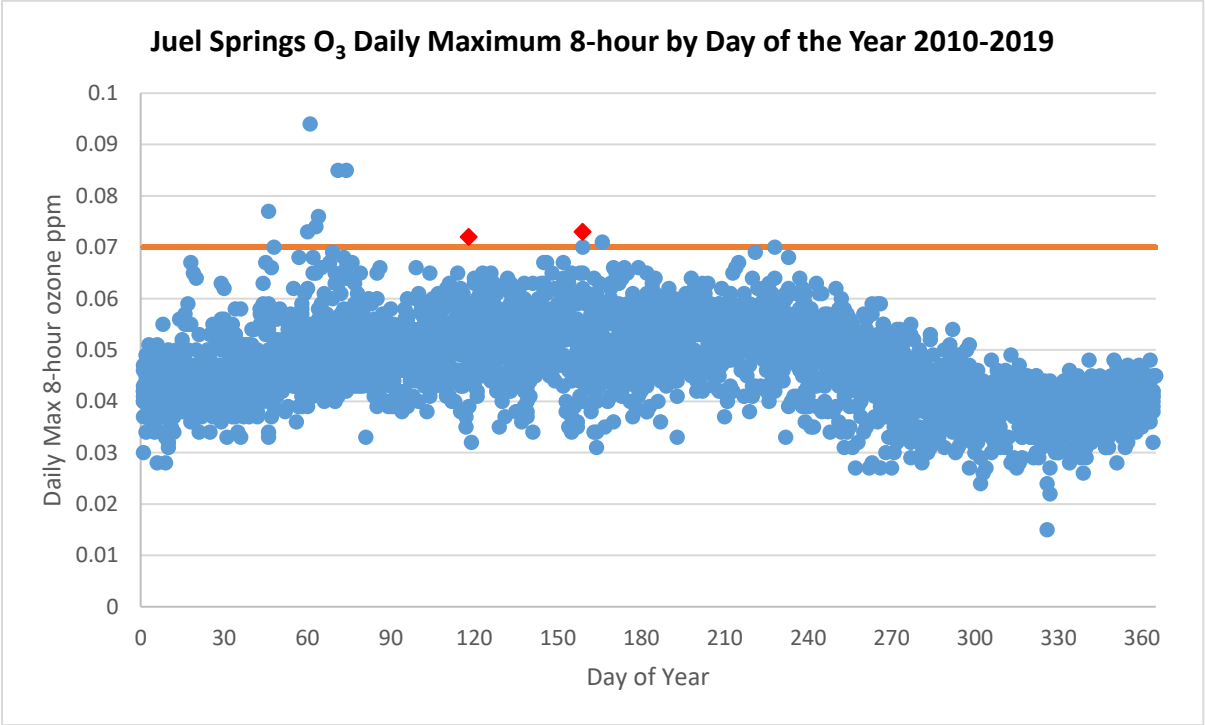


Figure 10. Historical comparison scatter plot for Moxa Arch daily 8-hour maximum ozone. SI events are indicated by red diamonds.

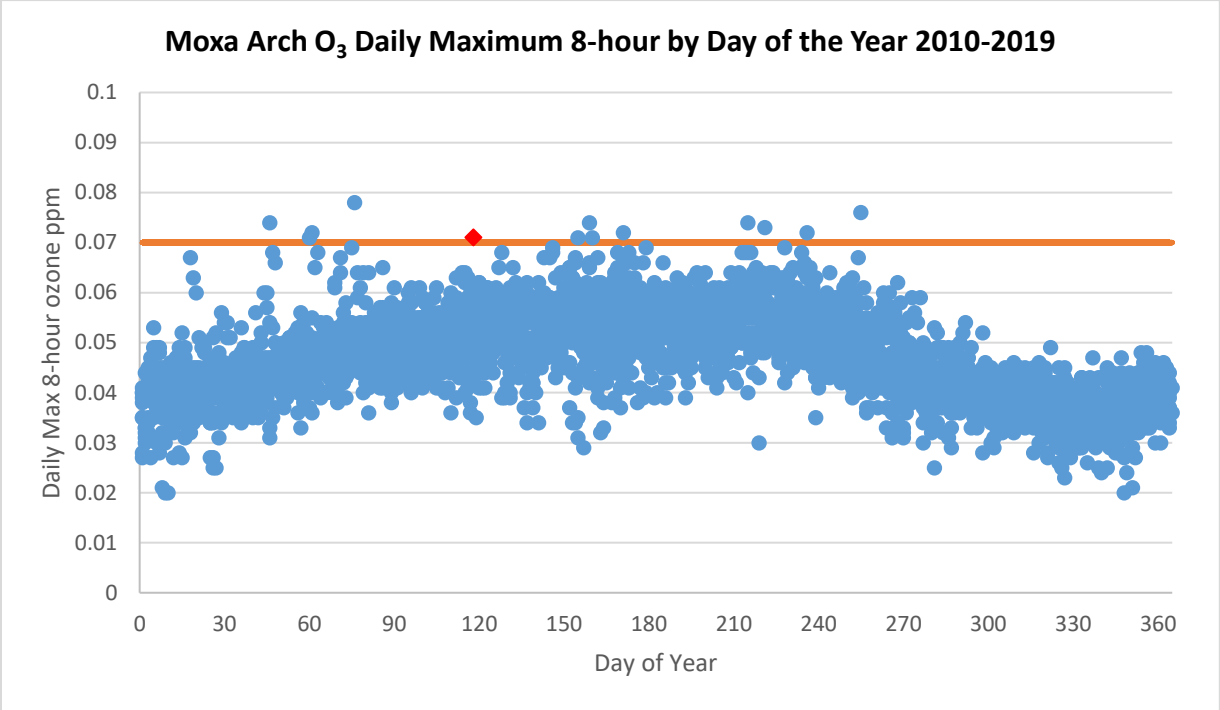
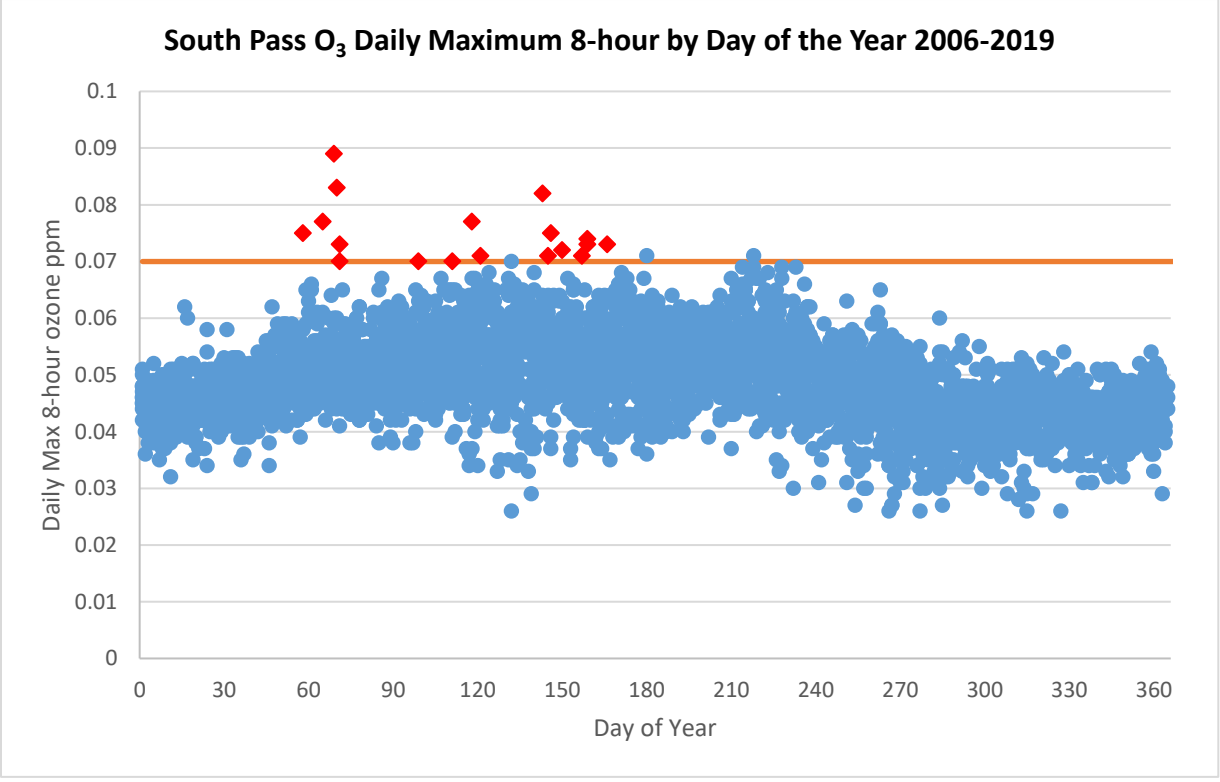


Figure 11. Historical comparison scatter plot for South Pass daily 8-hour maximum ozone. SI events are indicated by red diamonds.



DEMONSTRATION OF A CLEAR CAUSAL RELATIONSHIP BETWEEN THE EVENT AND EXCEEDANCE

Weather Overview

The NARR data depicts a vigorous upper level disturbance over Idaho/Montana/Wyoming at 5 AM MST April 28, 2019 (refer to Fig. 12). The upper level trough can be seen sagging down into western Wyoming in Fig. 12's 500 mb chart (top left). Throughout the day, the disturbance moved east and arrived in central South Dakota at 2 PM MST on April 28, 2019 (refer to Fig. 13). Another dataset, RAP, reinforces that the upper level disturbance was over the Wyoming-Montana border with an associated trough ejecting into western Wyoming (refer to Fig. 14) by 11 AM MST.

Figure 12. North America Reanalysis valid at 5 AM MST, April 28, 2019. Graphic courtesy of the Penn State University Department of Meteorology.

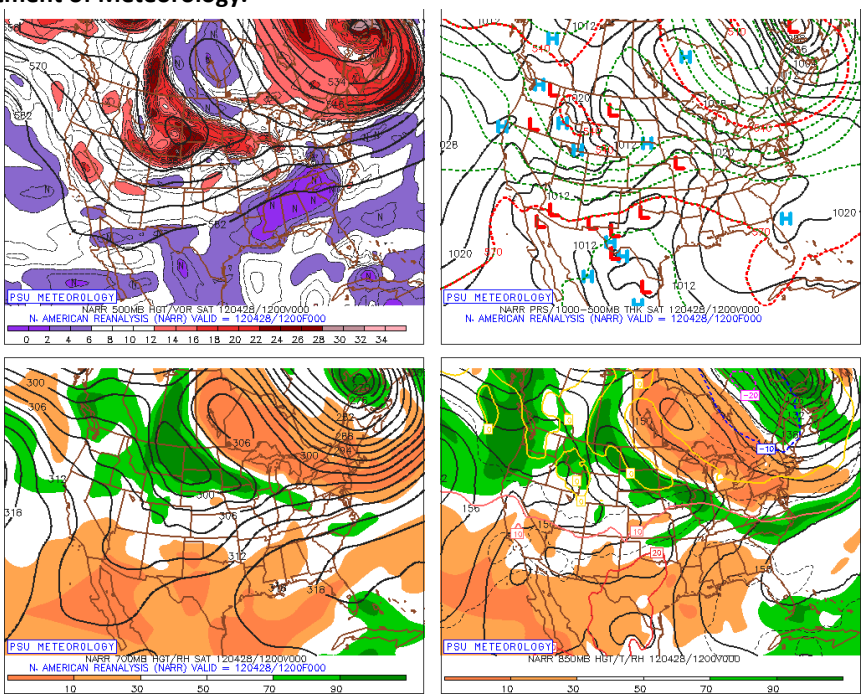


Figure 13. North America Reanalysis valid at 2 PM MST, April 28, 2019. Graphic courtesy the Penn State University Department of Meteorology.

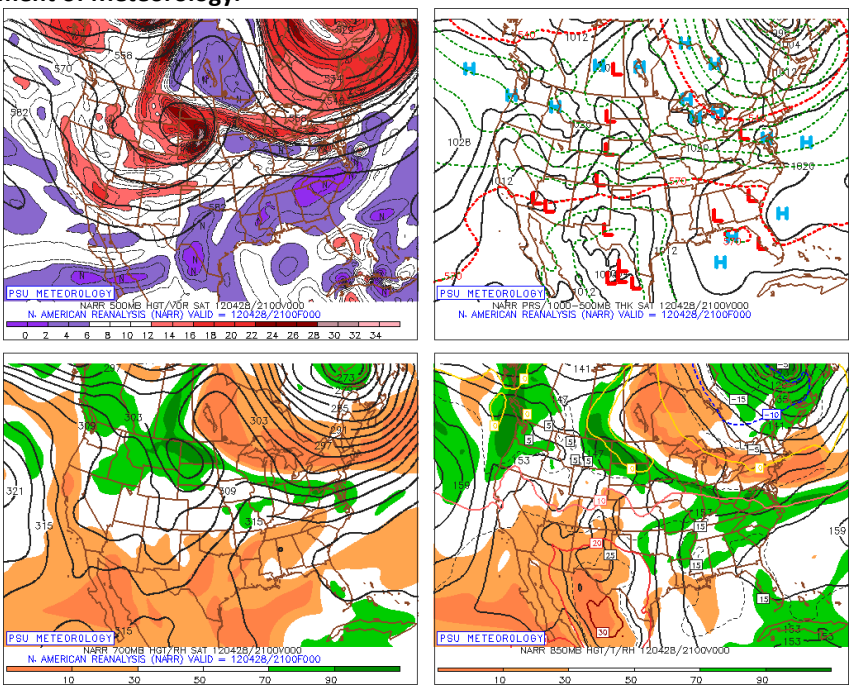
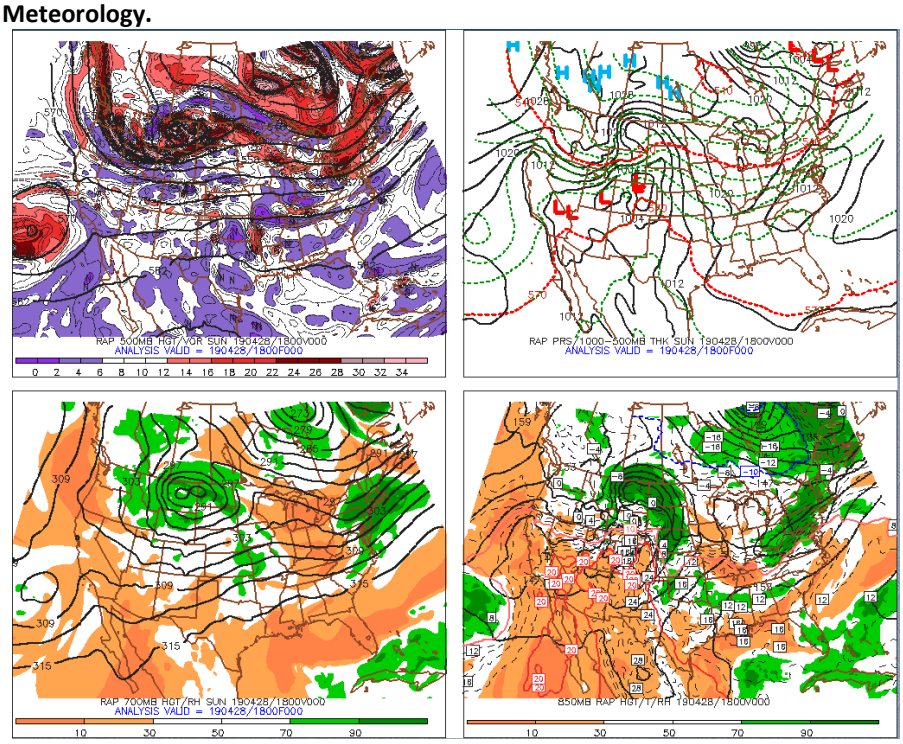
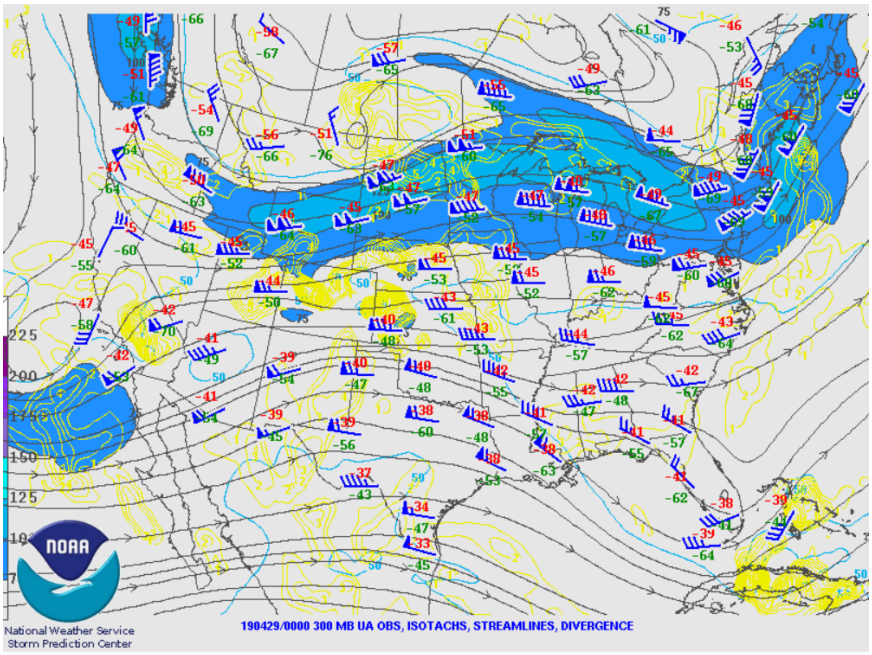


Figure 14. RAP Analysis valid at 11 AM MST, April 28, 2019. Graphic courtesy the Penn State University Department of Meteorology.



A 300 mb observations map on the evening of April 28 (Fig. 15) shows troughing that extends into Wyoming as well as an upper level jet streak of over 100 knots exiting the area of interest. This pattern is favorable for development of a fold in the tropopause near the region.

Figure 15. 300 mb observations valid at 5 PM MST on April 28, 2019. Graphic courtesy of NOAA Storm Prediction Center.



GOES Total Column Ozone Data

Because of the upper air disturbance and associated SI, a branch of higher ozone in yellow (increased Dobson values) can be seen on April 27, 2019, the day before the SI (refer to Fig. 16) extending down into western Wyoming. On the morning of April 28, 2019, total column ozone values greater than 350 Dobson Units (DUs) can be viewed on the GOES West satellite image (Fig. 17) branching down from the Pacific Northwest into Idaho and ultimately into western Wyoming.

Figure 16. OMI total ozone (DU) for April 27, 2019, the day before the SI. Image courtesy of KNMI/NASA.

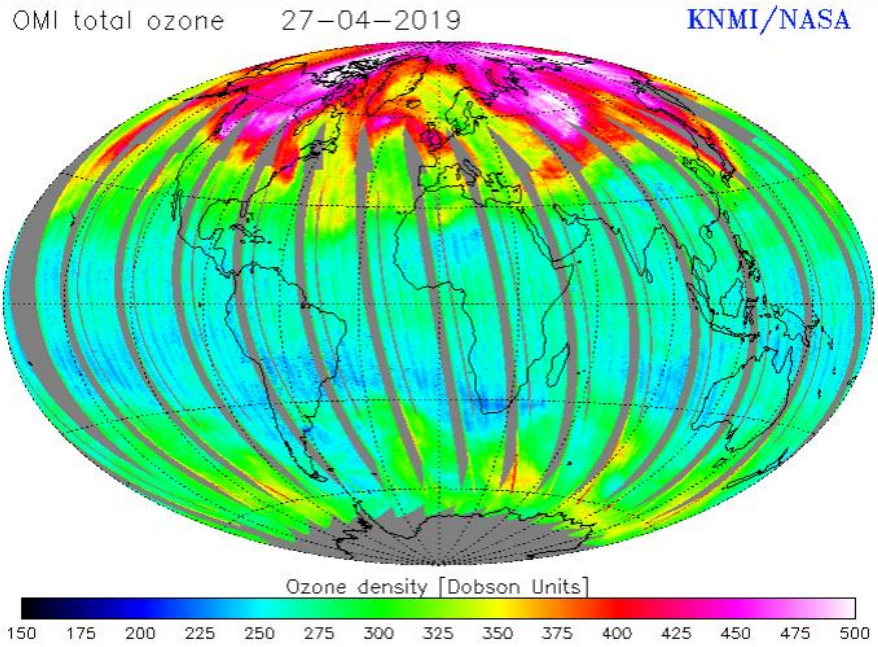
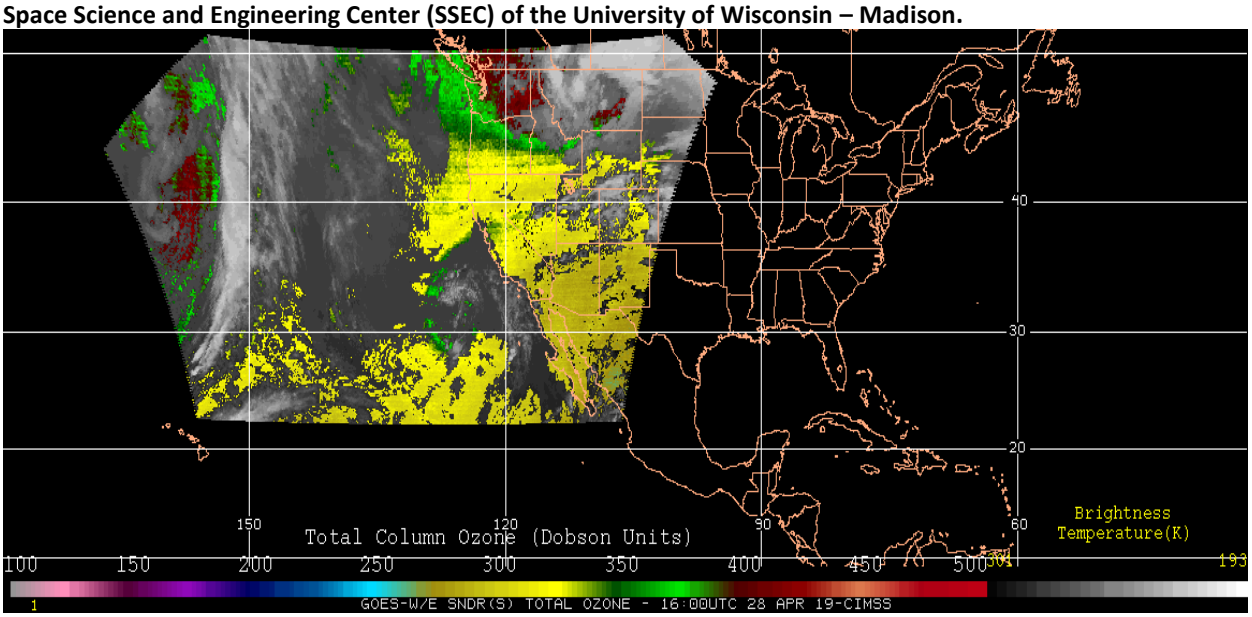


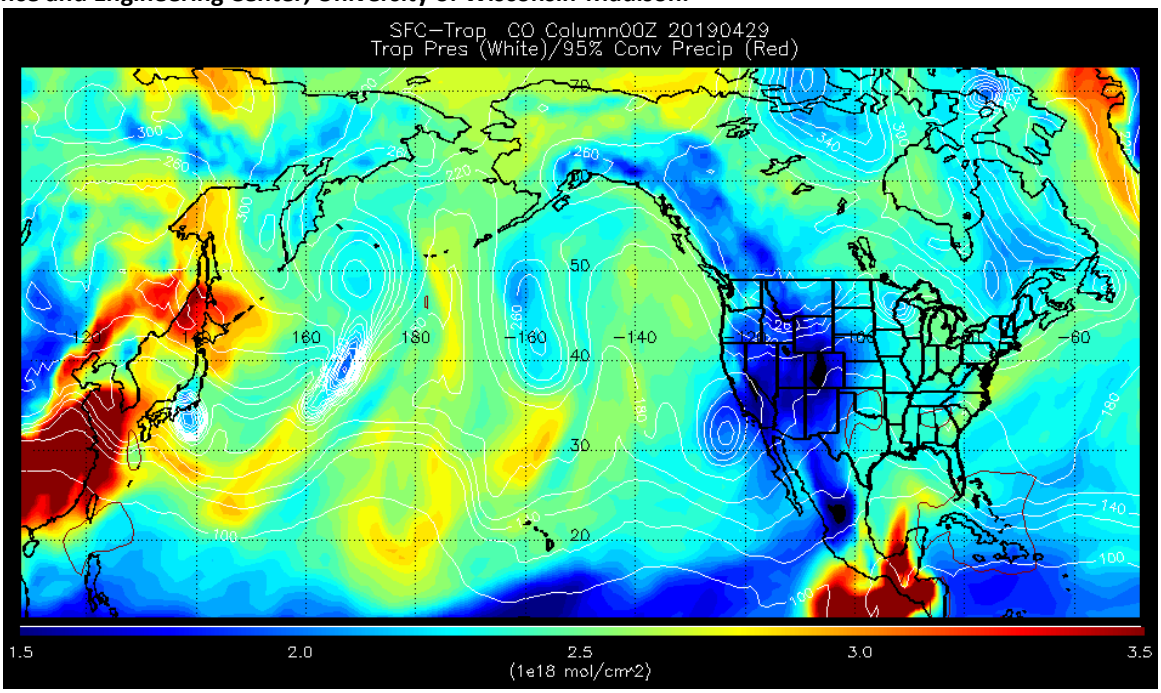
Figure 17. GOES total column ozone (DU) for 9 AM MST April 28, 2019. Image courtesy of the Data Center at the Space Science and Engineering Center (SSEC) of the University of Wisconsin – Madison.



Model-Estimated Tropospheric Carbon Monoxide Column from RAQMS

As mentioned in the introduction of this package, stratosperhic air contains little CO (Pan, Randel, et al. 2004; Newell, et al. 1999; Stoller, et al. 1999). In Figure 18, RAQMS model output shows estimates of very low CO concentrations ejecting into western Wyoming on the evening of April 28, 2019. This is complementary evidence to show that low CO air from the stratosphere was transported through the tropopause into parts of the free troposphere.

Figure 18. RAQMS model-estimated tropospheric CO column on April 28, 2019. Figure courtesy of the Space Science and Engineering Center, University of Wisconsin-Madison.



Isentropic Potential Vorticity, Relative Humidity, and Potential Temperature Vertical Cross-Sections

Stratospheric air can be "tagged" by identifying areas characterized by approximately greater than or equal to 1-PVU, dry air, and tightly packed (and sloping) isolines of PT. Using model 0-hour analyses, a descending SI can be illustrated by examining atmospheric vertical cross-sections over a time range. One can visualize an SI approaching the earth's surface by observing the temporal and vertical evolution of the greater than 1-PVU isoline, dry air, and the pattern of PT isolines superimposed on a cross-section of the earth's terrain.

Figure 19 shows the NAM-forecasted upper level system moved over western Wyoming, and an SI descended as shown by the descending three-dimensional branch of isentropic potential vorticity (IPV) circled in yellow at 11:00 MST. At this time, some effects were already seen at the surface with increasing ozone values, increasing wind speeds, and low RH. Figure 20 displays the 625 mb IPV greater than or equal to 1 PVU. Air with high potential vorticity (>1 PVU) streamed into western Wyoming by 2 PM MST. Figure 21, which displays a cross-section of potential temperature at 2 PM MST, has the sloping-down pattern of the theta (PT) isolines as is typical during an SI event. Finally, an RH cross-section (refer to Fig. 22) with a transect covering northcentral Idaho to the UGRB shows a tongue of low-RH air (20% RH or less)

stretching down from 10,000 m to about 4,000 m. This feature in tandem with the IPV and PT analyses helps prove stratospheric air impacted the region by descending into the troposphere.

Figure 19. Three-dimensional NAM forecasted IPV at 11 AM MST on April 28, 2019.

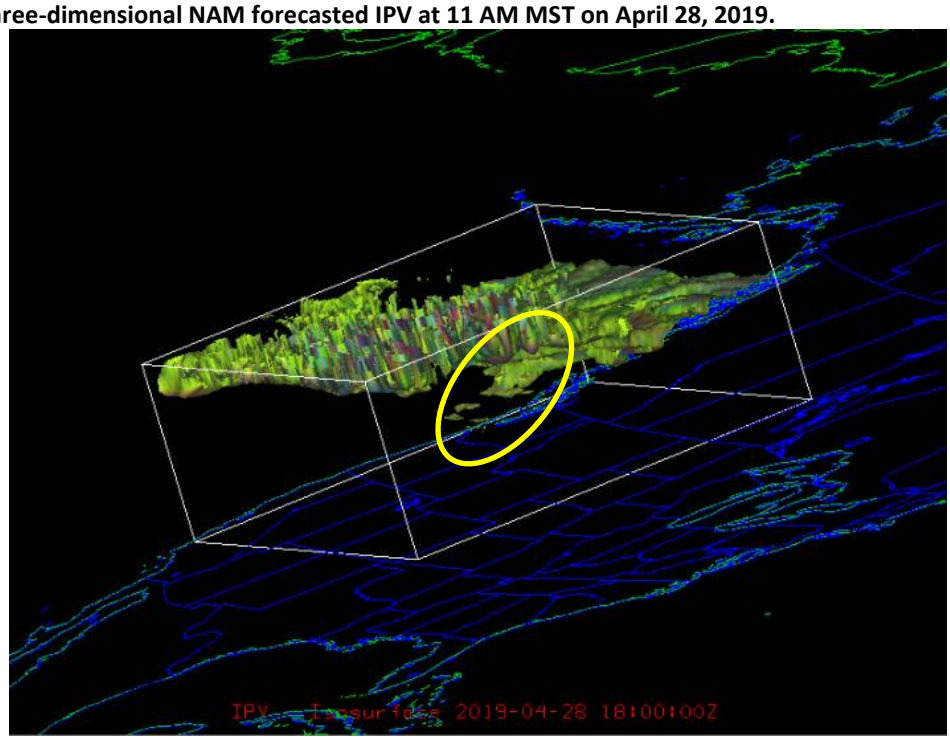


Figure 20. 625 mb IPV at 2 PM MST on April 28, 2019. Blue isolines indicates greater than or equal to 1-PVU air.

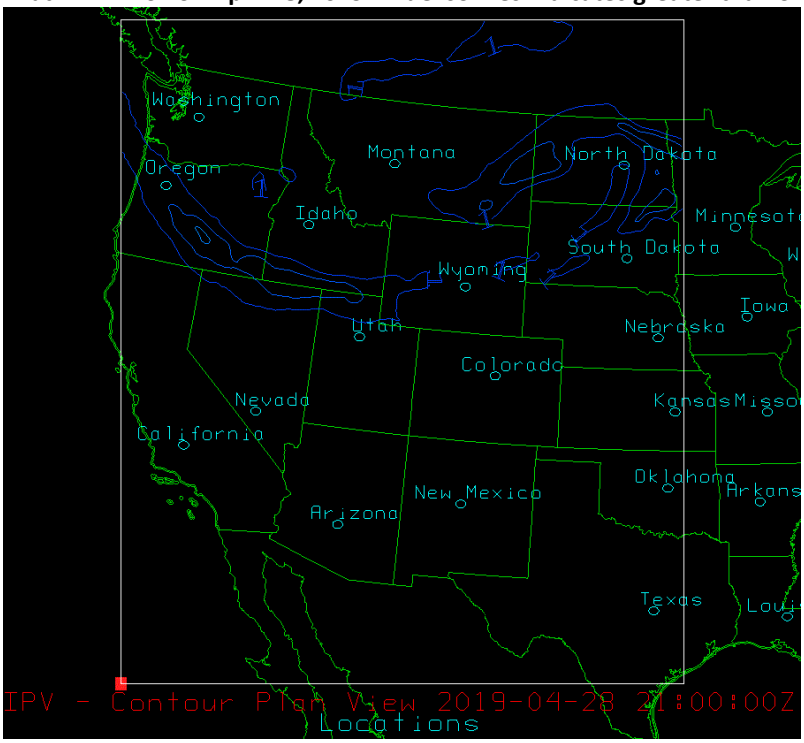


Figure 21. Three-dimensional cross-section of PT (K) at 2 PM MST on April 28, 2019.

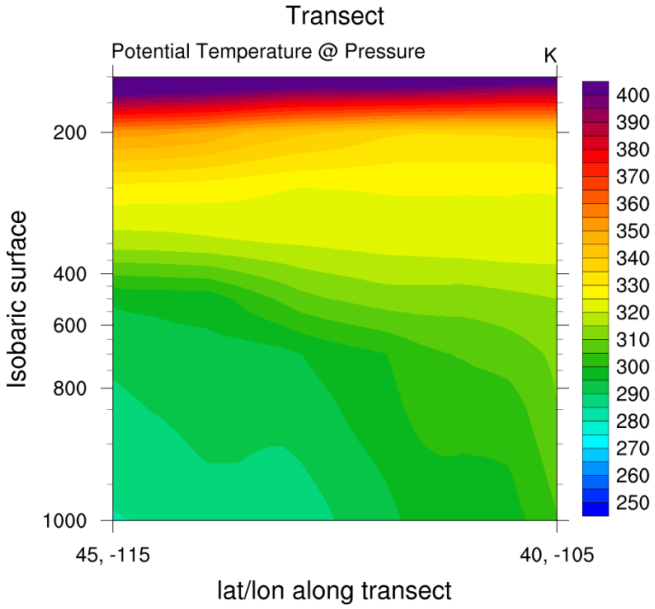
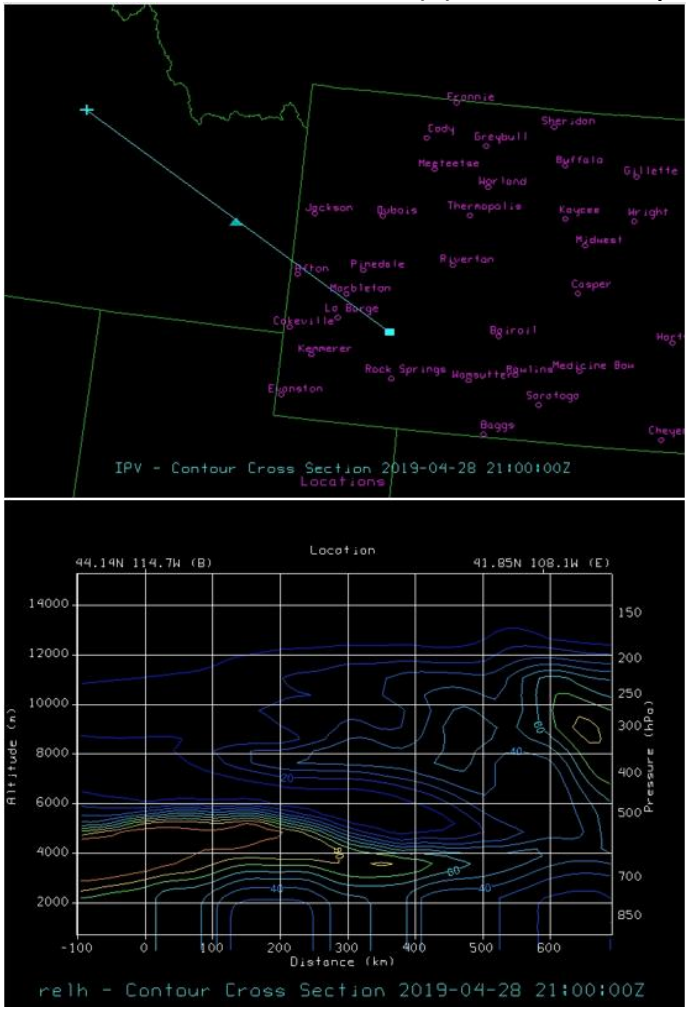


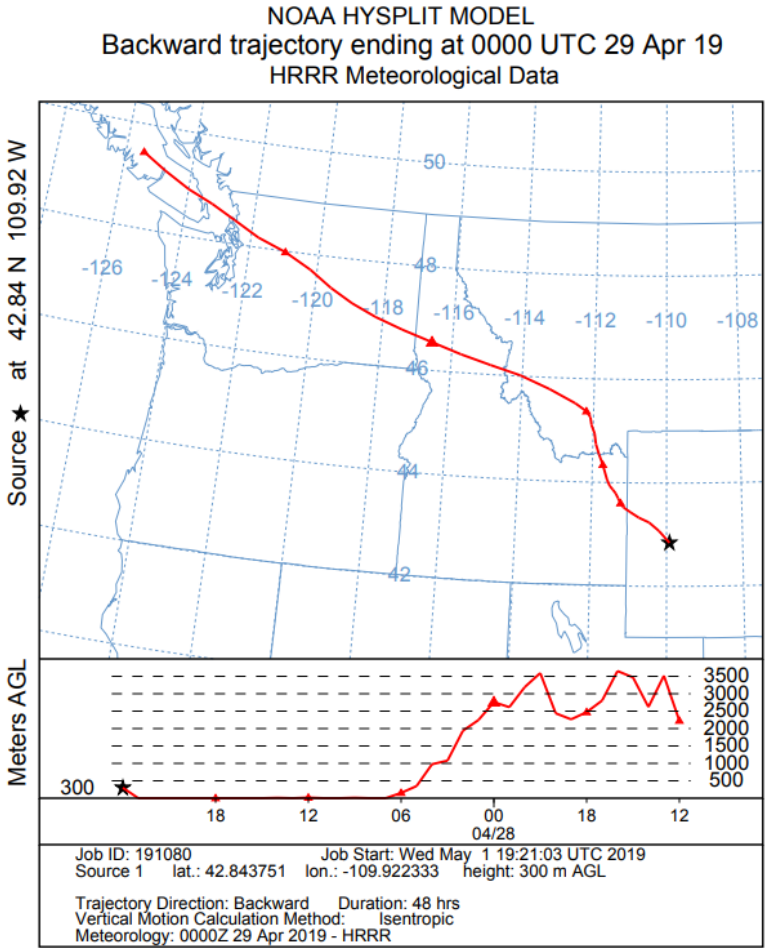
Figure 22. Transect and three-dimensional cross-section of RH (%) at 2 PM MST on April 28, 2019.



Back Trajectory Analysis

While cross-section analysis confirms an SI having occurred over western Wyoming, a back trajectory analysis is warranted to examine the path that the ozone-rich air took from the SI to the UGRB. Backward trajectory analyses occurred using the HYSPLIT program with HRRR 3-km data from August 26-August 28, 2019. Instead of analyzing one trajectory, the option of using HYSPLIT in ensemble mode was chosen to provide a more realistic likelihood of the air's pathway. Figure 23 shows mean backward trajectory emanating air parcels originating from the Pacific Northwest descended from heights 2-3.5 km above the ground layer. Upper air parcels reached the surface on the morning of April 28.

Figure 23. 48-hour backward HYSPLIT trajectory ending at 5 PM MST on April 28, 2019.



In Fig. 24, higher hourly ozone values already reached the surface in the UGRB at 11:00 AM MST. This is complementary evidence to HYSPLIT results showing stratospheric air extending down into the troposphere. Stronger winds out of the northwest from 20-25 kt look to have mixed down from the upper atmosphere as well in the figure below.

Figure 24. 11 AM MST, April 28, 2019 hourly ozone values. Image courtesy of AirNow-Tech Navigator.

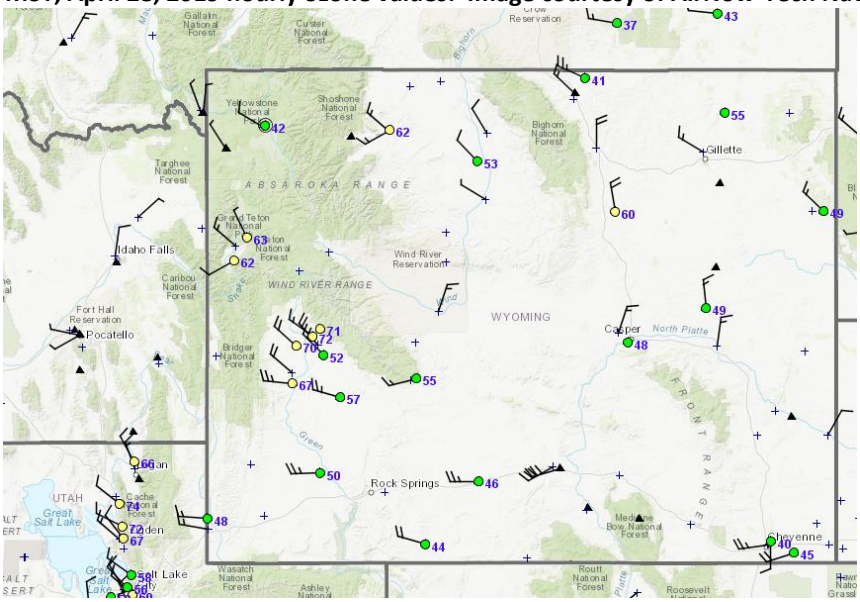
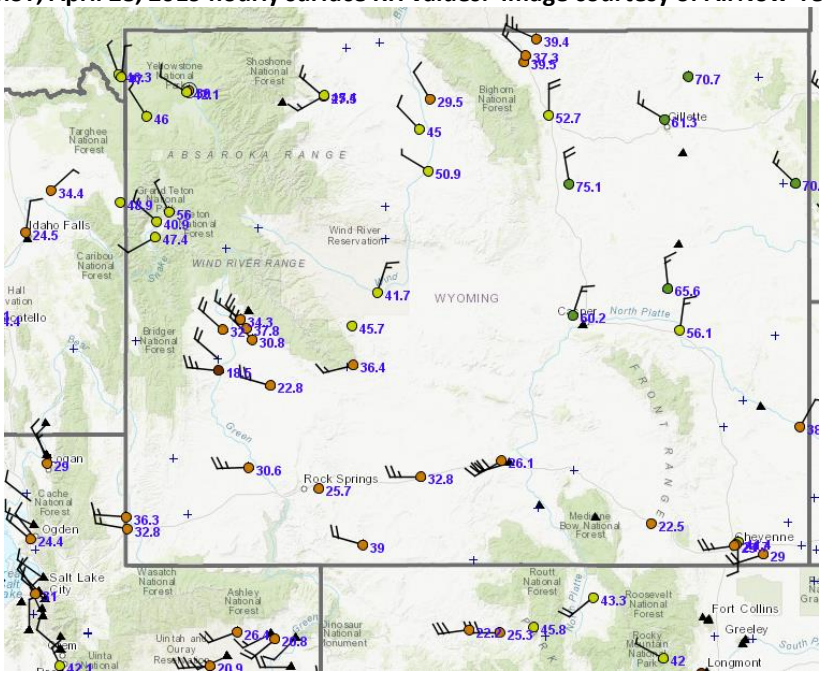


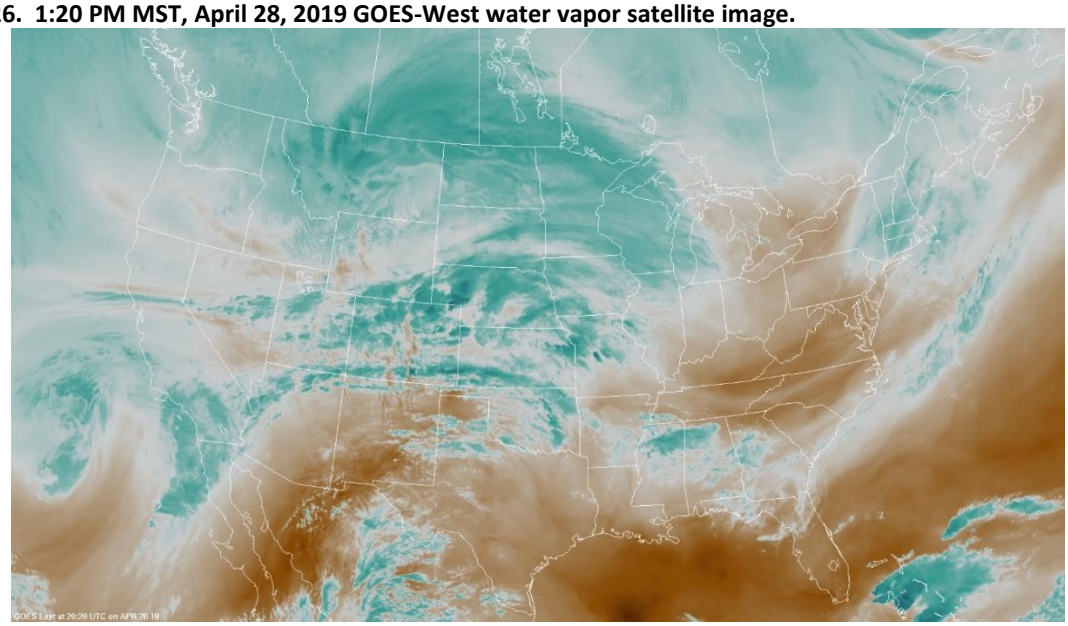
Figure 25 shows surface RH values near the UGRB ranged from 18-37% at 11 AM MST on the exceedance day, thus indicating very dry air moved into the region. The low surface RH values along with high IPV (shown earlier) is another piece of evidence that a SI event occurred.

Figure 25. 11 AM MST, April 28, 2019 hourly surface RH values. Image courtesy of AirNow-Tech Navigator.



A GOES-West water vapor satellite image from 1:20 PM MST in Fig. 26 better shows the drier air streaming into western Wyoming on April 28, 2019. Brown colors indicate much drier air over the region of interest, whereas greener colors indicate regions of higher atmospheric moisture.

Figure 26. 1:20 PM MST, April 28, 2019 GOES-West water vapor satellite image.



A time series of surface RH and surface ozone values at Moxa Arch for the period supports that a SI event occurred over the region on April 28, 2019. Figure 27 below shows 1-hour ozone values and 1-hour RH values with a dip in RH corresponding to a steady increase in 1-hour ozone values on April 28. Days leading up to the exceedance day had 1-hour ozone values that ranged from about 12 ppb to 65 ppb. On April 28, maximum 1-hour ozone values ranged from 76 to 92 ppb at the four AQD monitoring stations with exceedances. By April 29, the higher fetch of ozone mixed-out and 1-hour ozone values range from 35-49 ppb. Similar to Fig. 27, Fig. 28 shows the corresponding peak in 1-hour ozone and the minimum in RH that occurred at South Pass on April 28, 2019. South Pass tends to be more affected by stratospheric air, due to its higher elevation, and the same relationship between 1-hour ozone and RH exists on April 28.

Figure 27. Time series plot of surface ozone and surface RH values at Moxa Arch.

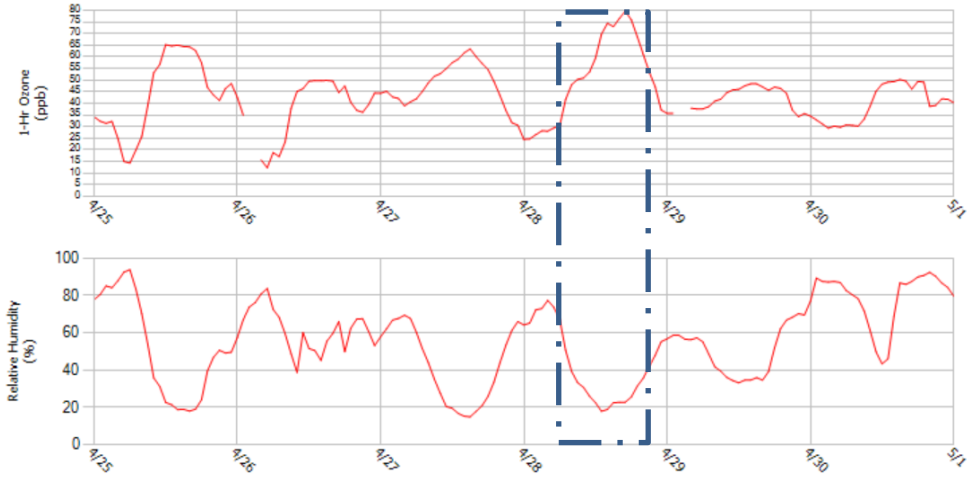
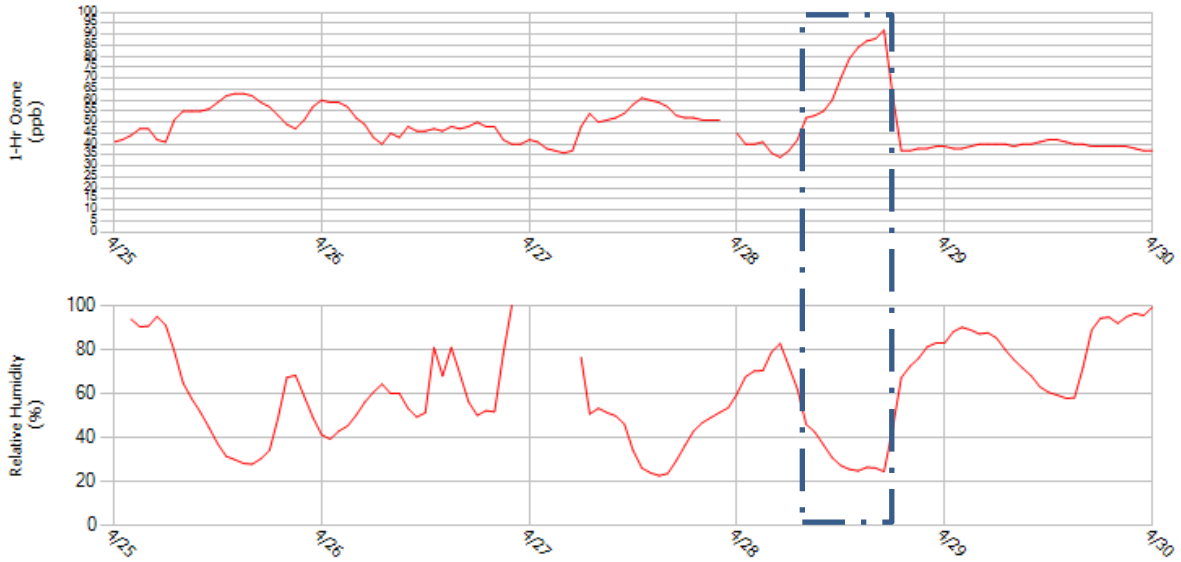


Figure 28. Time series plot of surface ozone and surface RH values at South Pass.



Stratospheric air has low concentrations of carbon monoxide (CO), so it is important to show this is true for the exceedance day in addition to the IPV and RH relationships. Because monitored CO data do not exist for the region, model-estimated tropospheric CO column data from the RAQMS model were shown previously in Fig. 18. By late afternoon of April 28, 2019, low CO column concentrations near 1.5 x 10^{18} mol/cm^2 are present in the western United States, including over western Wyoming. This region of low CO coincides with location of the upper air ejection and SI event.

Upper Air Soundings

Recall that a lowering of the tropopause or the existence of a dry air layer is another indication of a stratospheric air intrusion. By examining the April 28, 2019 radiosonde observation (RAOB) from Riverton, Wyoming, one can detect the presence of SI-air. The 5 AM MST April 28, 2019 Riverton RAOB (closest upper air site location) shows surface winds out of the northeast at 10 knots (11.5 mph), surface temperature at 4°C, and dew point at -2°C. Most of the very dry air looks to be located above 200 mb in the stratosphere, where the temperature and dew point spread is larger (Fig. 29). At 5 PM MST April 28, 2019, the Riverton RAOB shows that the driest air layer was between 550 and 500 mb (Fig. 31), but some dry air did make it down to the surface at 5 PM MST as indicated by the wide surface temperature and surface dew point spread. The surface temperature/surface dew point spread at 5 PM MST is about 17°C greater than the 5 AM MST spread.

Figure 29. Riverton, Wyoming RAOB at 5 AM MST, April 28, 2019. Image courtesy Plymouth State University Department of Atmospheric Science & Chemistry.

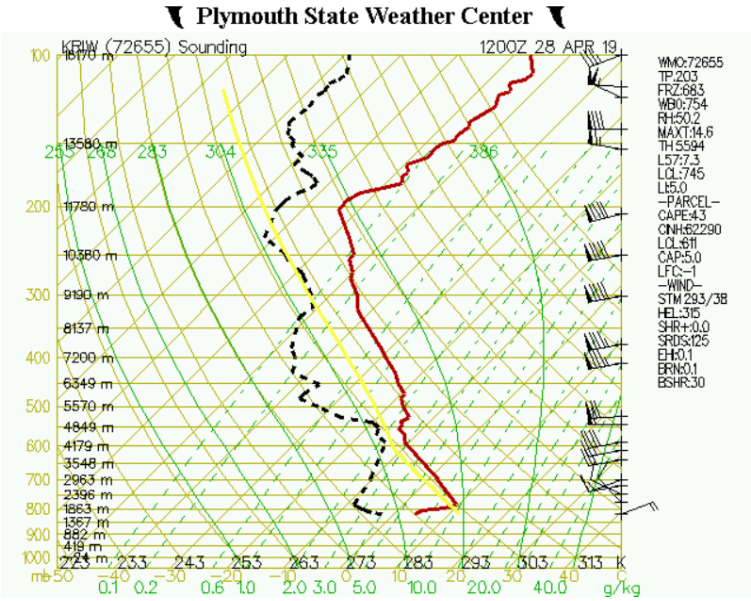


Figure 30 shows that the atmosphere was well-mixed (as shown by the dry adiabatic lapse rate in yellow) vertically up to the ozone-laden, dry air layer providing another piece of evidence that supports air from a SI having vertically mixed to the earth's surface.

Figure 30. Riverton, Wyoming RAOB at 5 pm MST, April 28, 2019. Image courtesy Plymouth State University Department of Atmospheric Science & Chemistry.

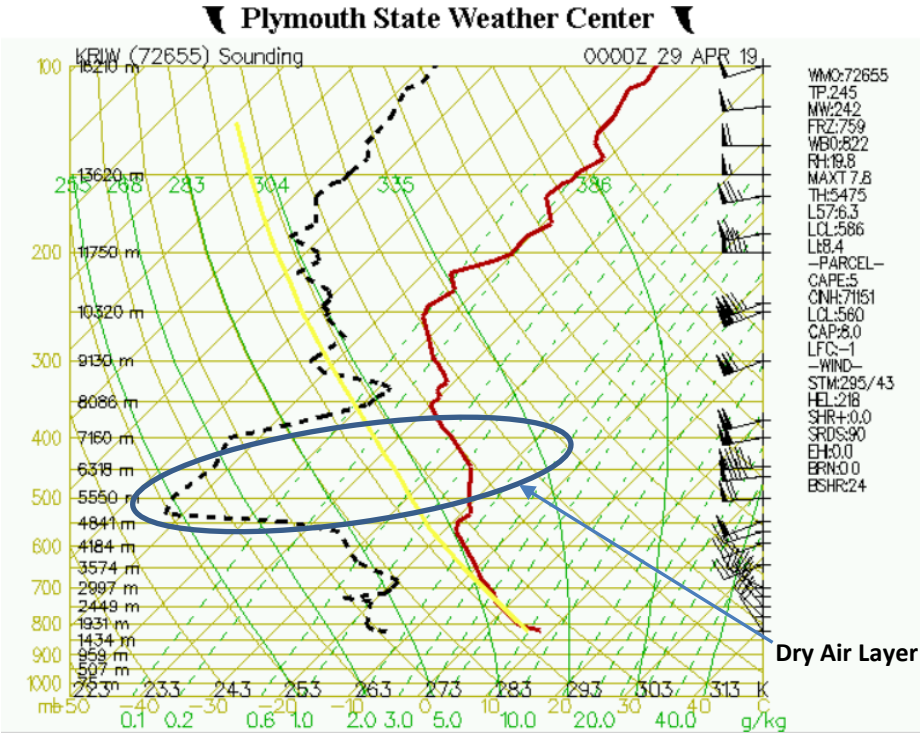
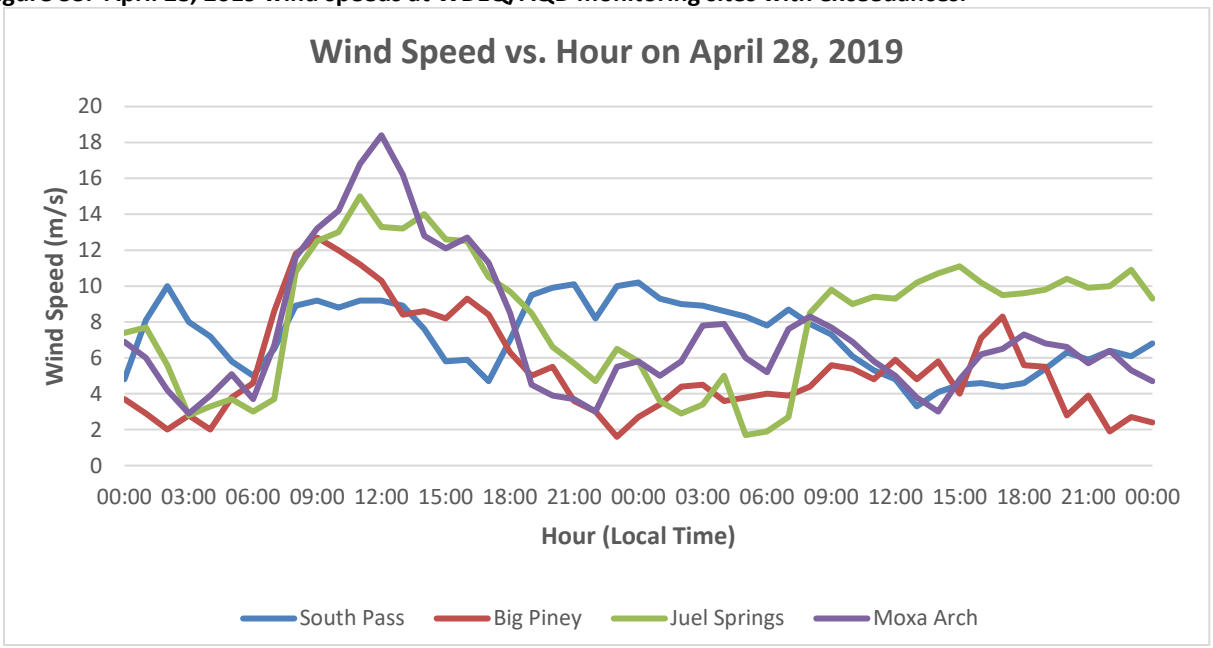


Figure 31 shows the April 28, 2019 1-hour averaged ozone and hourly RH data for the Big Piney, Juel Springs, Moxa Arch, and South Pass monitors. The data show a decrease in relative humidity (RH) that coincided with an increase in 1-hour average ozone values. Recall that air of stratospheric origin is dry as depicted by low RH content. An increase in ozone concentration and a decrease in RH at the monitoring sites is further evidence of an SI event having occurred on April 28, 2019. During the April 28, 2019 period of elevated ozone, strong winds (refer to Figs. 32 and 33) buffeted the UGRB prior to the SI event.

Figure 31. April 28, 2019 1-hour averaged ozone and RH at various WDEQ/AQD monitoring sites.

Figure 32. April 28, 2019 1-hour averaged ozone and wind speed at various WDEQ/AQD monitoring sites.

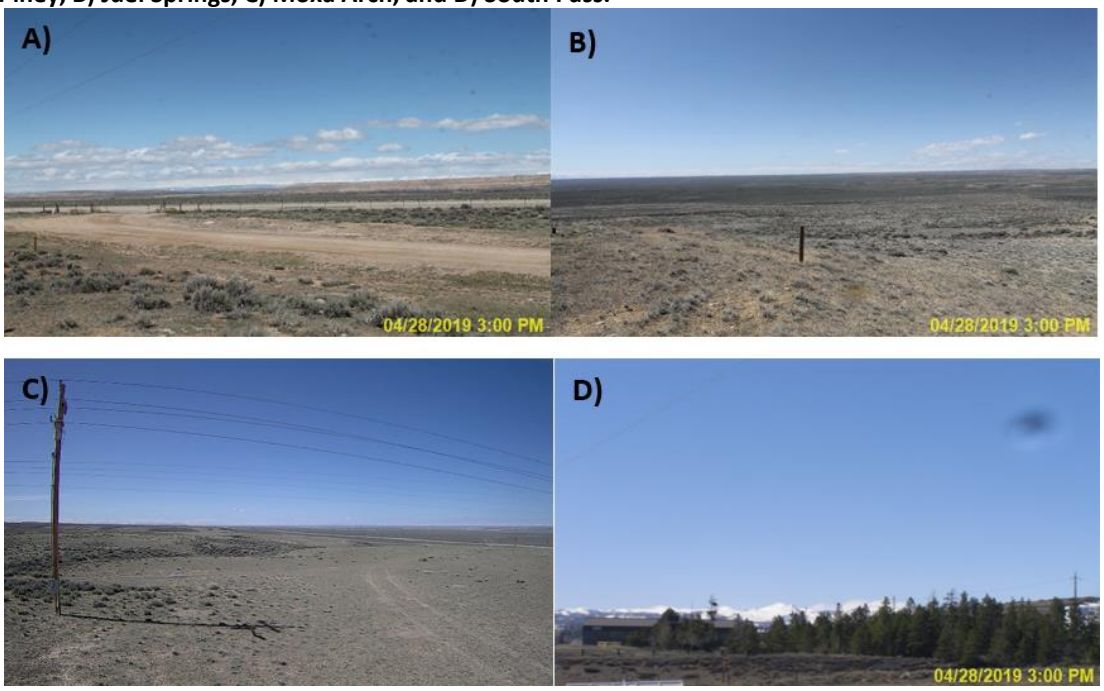
Figure 33. April 28, 2019 wind speeds at WDEQ/AQD monitoring sites with exceedances.



Comparison to Known Wintertime Anthropogenic UGRB Ozone Exceedance Events

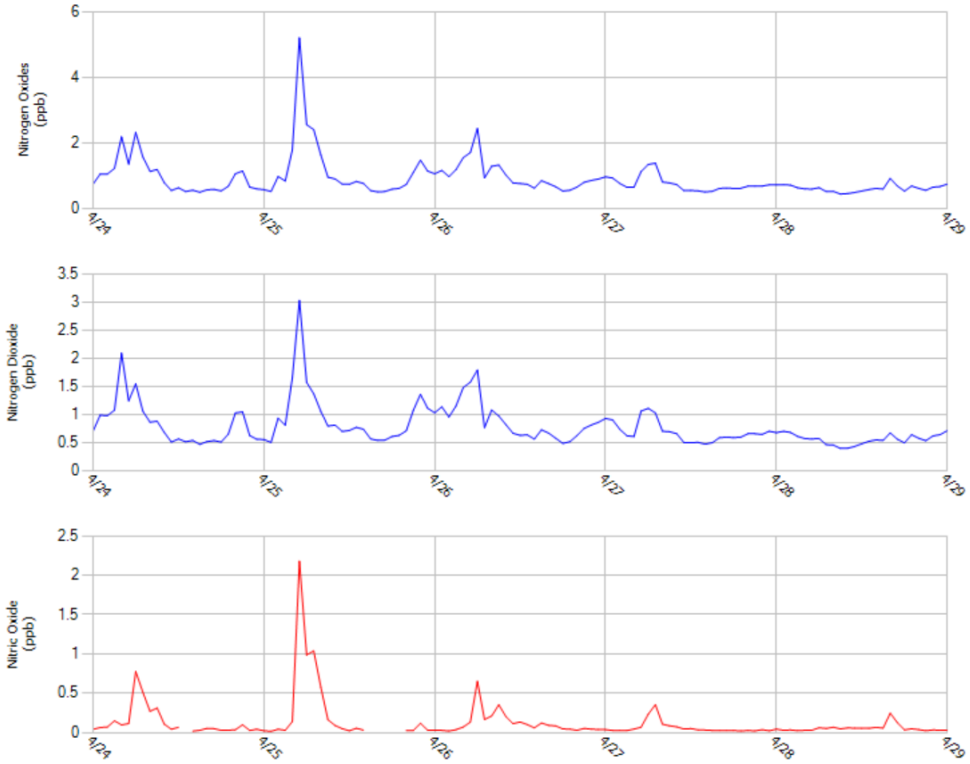
It has been documented (T. S. ENVIRON 2008) that elevated ozone values can occur at the UGRB ozone monitors of Boulder, Big Piney, Pinedale, Daniel, and Juel Springs because of light winds, snow cover, and strong inversions during the January-March winter ozone season. NOx and VOC precursor emissions from local sources are also needed to react with sunlight and form ozone. Figure 34 displays 2 PM MST webcam captures of the four (4) WDEQ/AQD monitoring sites that exceeded the ozone standard on April 28, 2019. None of these WDEQ/AQD monitoring sites had snow present at this time. In addition, high temperatures for this day ranged from 43°F at South Pass to 55°F at Moxa Arch. Skies were mostly clear, and previous wind speed data shows stronger winds at the surface during time of typical peak wintertime ozone production (refer to Fig. 33).

Figure 34. Webcam captures on April 28, 2019 at 2 PM MST for four WDEQ/AQD monitoring sites: A) Big Piney, B) Juel Springs, C) Moxa Arch, and D) South Pass.



Accumulation of surface-based ozone precursors did not occur because meteorological conditions were not supportive of precursor buildup prior to elevated ozone readings. Figure 35 shows various NOx species up to and on the date of the ozone exceedances for Big Piney. There is no obvious building of precursor NOx up to April 28, 2019. In fact, the plots of NOx trends show very little building or elevation on April 28. VOC precursor plots were not available for analysis during the SI episode.

Figure 35. NOx precursor emissions on days leading up to April 28, 2019 for Big Piney and the day of April 28.



SUMMARY AND CONCLUSIONS

During the interval from late winter to late spring in the northern hemisphere, weather producing systems (i.e. tropospheric storm systems, upper level disturbances or upper level storm systems) aid in causing the tropopause to "fold" or descend into the troposphere where our weather occurs. Tropopause folding permits ozone-rich air from the stratosphere to enter the troposphere, also called a stratospheric intrusion (SI), creating the potential for ground level ozone monitors over the higher terrain of the western United States to experience elevated readings.

Throughout April 28, 2019, an upper atmospheric disturbance associated with an SI moved over western Wyoming injecting ozone-rich air into the troposphere. The ozone-laden air then created elevated ozone readings resulting in 8-hour ozone standard exceedances of 74, 72, 71, and 77 ppb at the Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming ozone monitors, respectively.

Additionally, the ozone monitors in northeast Utah as well as several others in western Wyoming measured elevated 1-hour average ozone values from the low 60s to upper 60s ppb during the SI event. The Boulder monitoring station's ozone, NOx, and methane/non-methane parameters were not valid during this timeframe due to a calibrator malfunction.

It has been documented (T. S. ENVIRON 2008) that elevated ozone values can occur at the UGRB ozone monitors of Boulder, Big Piney, Pinedale, Daniel, and Juel Springs because of light winds, snow cover, and strong inversions coupled with anthropogenic emissions during the January-March winter ozone season. However, during the April 28, 2019 period of elevated ozone, strong winds buffeted the UGRB prior to the SI event, and no snow cover or strong inversions were present. Accumulation of surface-based ozone precursors did not occur because meteorological conditions were not supportive of precursor buildup prior to the elevated ozone readings.

The "Supporting Meteorological Data" and subsequent meteorological analyses sections of this document clearly show that an upper atmospheric disturbance and its attendant SI carried ozone-rich air from the stratosphere over central Idaho to the area around the Big Piney, Juel Springs, Moxa Arch, and South Pass ozone monitors during April 28, 2019. Due to the disturbance, tropospheric conditions were conducive for vertical mixing over the UGRB and southwest Wyoming as evidenced by the "Backward Trajectory Analyses," "Vertical mixing as shown by lapse rate analysis", and "Upper Air RAOB's" sections of this document. As a result, 1-hour average ozone values at the Big Piney, Juel Springs, Moxa Arch, and South Pass ozone monitors increased during April 28, 2019.

This event meets the definition of a stratospheric intrusion as outlined in the preamble to "Treatment of Data Influenced by Exceptional Events" 40 CFR Parts 50 and 51 section IV(D)(5)(e). Specifically, air originated in the stratosphere and was transported directly to the earth's surface via an upper level disturbance causing the Big Piney, Juel Springs, Moxa Arch, and South Pass April 28, 2019 exceptional event. This event meets the specific criteria established in 40 CFR 50.14 (c)(3)(iv) as described below.

Criteria **(A)** requires "[a] narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s)"

Criteria **(B)** requires a "[d]emonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance of violation"

Criteria **(C)** requires an "[a]nalysis comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times…"

Criteria **(D)** requires a "[d]emonstration that the event was both not reasonably controllable and not reasonably preventable"

Criteria **(E)** requires "[a] demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event."

The causal relationship is a basic one in which the ozone standard exceedance was caused by tropospheric folding resulting in an SI. For the exceedances that occurred on April 28, 2019, an intrusion of stratospheric air occurred over Idaho upwind of the Big Piney, Juel Springs, Moxa Arch, and South Pass monitors and injected ozone-rich air into the area above and surrounding the UGRB and other parts of western Wyoming. The causal nature of the SI's impact on ozone values at the WDEQ/AQD ozone monitors is further supported by the corroboration of ground-based air quality data to the spatial and temporal accuracy of the meteorological analysis.

On April 28, 2019, the four exceeding sites ranked in the top six highest 8-hour concentrations for the time period of 2014-2019. Big Piney and South Pass ranked number one, Juel Springs ranked number three, and Moxa Arch ranked number six. Also during this day, all 8-hour maximum ozone data from the exceeding monitoring sites were in the 99th percentile or greater.

In brief, the WDEQ/AQD concludes that the event that occurred during April 28, 2019 meets the three core statutory elements that define an exceptional event per 40 CFR 50.1(j). WEDQ/AQD has provided the elements required to justify data exclusion as identified in A-E of 40 CFR 50.14 (c)(3)(iv). Consequently, the WDEQ/AQD is requesting for EPA concurrence that the event was exceptional and for the exclusion from AQS database of the Big Piney, Juel Springs, Moxa Arch, and South Pass 1-hour average ozone data for the following times:

Table 4. Big Piney, Juel Springs, Moxa Arch, and South Pass times and dates for AQS data exclusion.

Site	Begin Time/Date(s)	End Time/Date(s)
Big Piney	0000 MST April 28, 2019	2400 MST April 28, 2019
Juel Springs	0000 MST April 28, 2019	2400 MST April 28, 2019
Moxa Arch	0000 MST April 28, 2019	2400 MST April 28, 2019
South Pass	0000 MST April 28, 2019	2400 MST April 28, 2019

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APPENDIX – Station QA Audit Reports.

WDEQ

Audit Spreadsheet Setup Menu

Date: 06/19/18
Time: 12:30
Time Zone: MT
Auditor: Steve Mugg
Witness: Reed Manes

Site name: Big Piney
Operator: MSI
Project: WDEQ QA Audits

Data Acquisition System: Campbell Scientific CR23X
S/N: 5746

Coordinates
Latitude: 42.4864
Longitude: -110.0989

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	01/27/17
Ozone transfer std:	TAPI	M700EU	173	01/27/17
Zero air system:	TAPI	701H	745	NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC355044	05/13/16	05/13/19			

Standard		***Trace Level***	
NOX	8.964		
NOX	8.950		
SO2	8.741		
CO	90.56		
Propane	202.3		
Methane	614.6		

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.0002	-1.50	cc/min
Gas flow 0-200 cc/min factors:	0.9997	0.04	cc/min
Gas flow 0-20 cc/min factors:	0.99966	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.000	ppm

Site Monitoring Equipment

STATION
Big Piney

DATE
06/19/18

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Thermo	49i	1018243135	0.150 ppm
Nitric Oxide	Thermo	42i-TL	1109147798	0.100 ppm
Nitrogen Oxides	Thermo	42i-TL	1018243135	0.100 ppm
Nitrogen Dioxide	Thermo	42i-TL	1018243135	0.100 ppm

METEOROLOGICAL SENSORS

Parameter	Manufacturer	Model	Serial No.	Range
Wind Speed 10 m	RM Young	5305	100333	0 - 50 m/s
Wind Direction 10 m	RM Young	5305	100333	359°
Temperature 2 m	RM Young	41342	17953	-30.0 to 50.0 Deg C
Temperature 9 m	RM Young	41342	17954	-30.0 to 50.0 Deg C
Precipitation	Met One	385	N9390	NA
Solar Radiation	Hukesflux	LP02-L	41038	0 - 1500 W/m2
Relative Humidity	Vaisala	HMP45C	F4430125	0-100 %
Pressure	Vaisala	PTB110	F1220017	600 - 1060 hPa

Site: Big Piney
Project: WDEQ QA Audits
Operator: MSI

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
6/19/2018	**Ozone**	6.7	0.9361	0.0020	1.0000
6/19/2018	**Nitric Oxide**	0.8	1.0114	-0.0007	0.9999
6/19/2018	**Nitrogen Oxides**	-5.1	1.0092	-0.0008	0.9999
6/19/2018	**Nitrogen Dioxide**	0.9	1.0100	-0.0001	1.0000

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

METEOROLOGICAL SENSORS

Audit Date	Sensor	Audit Input	DAS Diff.	Audit Criteria
6/19/2018	**Wind Speed (10 meters)**	**m/s**	**m/s**	
		0.00	0.0	±.25 m/s < 5 m/s
		2.56	0.0	
		m/s	**%**	
		5.12	0.0	± 5%; ws > 5 m/s
		10.24	0.0	
		20.48	0.0	
		40.96	0.0	
6/19/2018	**Wind Direction (10 meters)**	**Deg**	**Deg**	
		30	-1	± 5 degrees
		60	-1	
		90	-1	
		120	-2	
6/19/2018	**Temperature (2 meters)**	**Deg C**	**Deg C**	
		0.1	0.0	± 1.0 degree Celsius
		14.0	0.2	
		30.8	0.0	
6/19/2018	**Precipitation**	**mm**	**%**	
		0.27	-100.0	±10% of input
6/19/2018	**Solar Radiation**	**W/m2**	**%**	± 10%
		0	#DIV/0!	
		0	#DIV/0!	

6/19/2018	**Relative Humidity**	**%** 53.2 76.4 #REF!	**%** 3.6 6.7 #REF!	± 10%
6/19/2018	**Pressure**	**mm** 794.0	**mm** 0.8	± 2.3 mm Hg
6/19/2018	**Temperature (Delta T 2-10 meters)**	**Deg C** 0.1 14.1 30.8	**Deg C** 0.02 -0.03 -0.03	± 0.1°C

AUDIT RECORD

HORIZONTAL WIND SPEED

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **11:47**
Finish: **13:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site Name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **100333**
K factor: **3.8**
Range: **0 - 50** **m/s**

Model: **5305**
Sensor Ht.: **10 meters**
Starting torque: **0.2** **gm cm**
Starting threshold: **0.23** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Input m/s	DAS m/s	Diff. m/s
1	0.00	0.00	0.00
2	2.56	2.56	0.00

Audit Criteria: ±.25 m/s; ws ≤ 5 m/s

Audit Point	Input m/s	DAS m/s	Diff. %
3	5.12	5.12	0.0
4	10.24	10.24	0.0
5	20.48	20.48	0.0
6	40.96	40.96	0.0

Audit Criteria: ± 5%; ws > 5 m/s

Comments: No problems noted.

AUDIT RECORD

HORIZONTAL WIND DIRECTION

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **11:47**
Finish: **13:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site Name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **100333**
K factor: **37**
Range: **359°**
rossarm Orientation: **180°**

Model: **5305**
Sensor Ht.: **10 meters**
Starting torque: **8** **gm cm**
Starting threshold: **0.26** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Degrees Reference	Degrees DAS	Diff. Degrees
1	30	29	-1
2	60	59	-1
3	90	89	-1
4	120	118	-2
5	150	149	-1
6	180	179	-1
7	210	209	-1
8	240	240	0
9	270	271	1
10	300	301	1
11	330	331	1
12	0	0	0

Audit Criteria ± 5 degrees

Comments: No problems were noted.

AUDIT RECORD

AMBIENT TEMPERATURE

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **11:47**
Finish: **13:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site Name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **17953**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **2 m**

Audit Point	Input Deg C	DAS Deg C	Diff. Deg C
1	0.1	0.1	0.0
2	14.0	14.2	0.2
3	30.8	30.8	0.0

Audit Criteria: ± 1.0°C

Comments: No problems noted.

AUDIT RECORD

TEMPERATURE DIFFERENCE (DELTA-T)

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **11:47**
Finish: **13:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site Name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **19954**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **9 m**

Audit Point	Input Deg C	2-9 Temp Diff Deg C
1	0.1	0.024
2	14.1	-0.034
3	30.8	-0.026

Audit Criteria: ± 0.1°C

Comments: No problems were noted.

AUDIT RECORD

PRECIPITATION

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **14:00**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Met One**
Serial No.: **N9390**
Units: **in**

Model: **12" HTD Rain Gauge**
Sensor Ht.: **2.0 m above ground**
Funnel Diam.: **12** **inch**

Audit Point	Input Inches	DAS Inches	Diff. %
1	0.27	0.00	-100.0

Audit Criteria ±10% of input

Comments: No audit performed due to persistant rain.

AUDIT RECORD

SOLAR RADIATION

Wyoming
Department of Environmental Quality

Date: **6/19/18**
Start: **13:00**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **Hukseflux**
Serial No.: **41038**
Range: **0 - 1500 W/m2**

Model: **LP02**
Sensor Ht.: **2.5 meters**

Audit Point	Input W/m2	DAS W/m2	Diff. %
1	0	0	#DIV/0!
2	0	0	#DIV/0!

Criteria: ±10%

Comments: No audit performed due to persistant cloud cover.

AUDIT RECORD

RELATIVE HUMIDITY

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **13:00**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **Vaisala**
Serial No.: **F1640015**
Range: **0-100 %**

Model: **HMP45AC**
Sensor Ht.: **2 meters**

Audit Point	Input RH (%)	DAS RH (%)	Diff. %
1	53.2	56.8	3.6
2	76.4	83.1	6.7
3	52.1	56.3	4.2

Criteria: ± 10%

Comments: No problems noted.

AUDIT RECORD

BAROMETRIC PRESSURE

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **11:47**
Finish: **13:00**
Auditor: **Steve Mugg**
Witness: **Reed Manes**

Site name: **Big Piney**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Vaisala**
Serial No.: **F1220017**
Units: **mb**

Model: **PTB110**
Sensor Ht.: **1.5 m**

Audit Point	Input mb	DAS mb	Diff. mb
1	794.0	794.8	0.8

Audit Criteria: ± 3.0mb

Comments: No problems were noted.

WDEQ

Audit Spreadsheet Setup Menu

Date: 06/17/19
Time: 15:20
Time Zone: MT
Auditor: Steve Mugg
Witness: Adam Lenkowski

Site name: Juel Springs
Operator: MSI
Project: WDEQ QA Audits

Data Acquisition System: CR1000
S/N: 4912

Coordinates
Latitude: 42.3735
Longitude: -109.5605

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	01/17/2019
Ozone transfer std:	TAPI	M700EU	173	01/17/19
Zero air system:	TAPI	701H		NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC476183	06/13/19	06/13/22			

Standard		***Trace Level***	
NOX	8.734		
NO	8.562		
SO2	3.111		
CO	90.31		
Propane	196.8		
Methane	601.9		

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.0002	-1.50	cc/min
Gas flow 0-200 cc/min factors:	0.9997	0.04	cc/min
Gas flow 0-20 cc/min factors:	0.9997	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.000	ppm

Site Monitoring Equipment

STATION
Juel Springs

DATE
06/17/19

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Teledyne	400E	1873	0.150 PPM
Nitric Oxide	Thermo Scientific	42i	1180430014	0.200 ppm
Nitrogen Oxides	Thermo Scientific	42i	1180430014	0.200 ppm
Nitrogen Dioxide	Thermo Scientific	42i	1180430014	0.200 ppm

Site: Juel Springs
Project: WDEQ QA Audits
Operator: MSI

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
6/17/2019	**Ozone**	-6.3	0.9136	0.0015	0.9999
6/17/2019	**Nitric Oxide**	0.3	1.0028	-0.1192	1.0000
6/17/2019	**Nitrogen Oxides**	1.8	1.0054	0.0450	0.9999
6/17/2019	**Nitrogen Dioxide**	5.2	1.0396	0.0201	1.0000

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

AUDIT RECORD

OZONE

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **19:40**
Finish: **20:10**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Teledyne**
Serial No.: **1873**
Sample flow: **631 cc/m**

Model: **400E**

Range: **0.150 PPM**

O_3 Audit Level	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
Zero	0.000	0.002	
2	0.016	0.016	0.0
3	0.034	0.032	-5.9
5	0.079	0.074	-6.3

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.914
Intercept:	0.002
Correlation:	0.9999

Percent difference of audit levels 3-10 <±15.1%. Audit levels 1&2 <±1.5 ppb difference or <±15.1%.

Comments: No problems noted.

Audit Equipment	Make	Model	ID	Certification Date
Dilution System:	TAPI	M700EU	173	01/17/2019
Ozone Standard:	TAPI	M700EU	173	01/17/19
Zero Air System:	TAPI	701H	0	NA

Ozone Transfer Standard			
Sample Freq:	NA	Cell Temperature:	NA deg C
Control Freq:	NA	Ambient Pressure:	NA "Hg
Span Setting:	NA	Certification Slope:	1.0000
		Certification Intercept:	0.0000 ppm

AUDIT RECORD

NITRIC OXIDE

Department of Environmental Quality

Date: **06/17/19**
Start: **15:20**
Finish: **14:30**
Auditor: **Steve Mugg**
Witness: **Adam**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo Scientific**
Serial No.: **1180430014**
Sample flow: **509 cc/m**
Range: **0.200 ppm**

Model: **42i**

NO Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
5	30.3	30.2	-0.3
6	61.3	61.2	-0.2
7	115.6	115.9	0.3

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0028
Intercept:	-0.1192
Correlation:	1.0000

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

OXIDES OF NITROGEN

Wyoming Department of Environmental Quality

Date: **06/17/19**
Start: **15:20**
Finish: **14:30**
Auditor: **Steve Mugg**
Witness: **Adam**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo Scientific**
Serial No.: **1180430014**
Sample flow: **509 cc/m**
Range: **0.200 ppm**

Model: **42i**

NO_x Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
5	30.3	30.1	-0.7
6	60.5	61.6	1.8
7	115.8	116.2	0.3

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0054
Intercept:	0.0450
Correlation:	0.9999

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

NITROGEN DIOXIDE

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **15:20**
Finish: **14:30**
Auditor: **Steve Mugg**
Witness: **Adam**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo Scientific**
Serial No.: **1180430014**
Sample flow: **509 cc/m**
Range: **0.200 ppm**

Model: **42i**
Converter T.: **315 Deg C**

NO_2 Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
2	3.9	4.0	2.6
3	13.4	14.1	5.2
5	31.2	32.4	3.8

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0396
Intercept:	0.0201
Correlation:	1.0000

Converter Efficiency
99%

Comments: Input audit level 2, 3.4 PPB, the output was 4.0 PPB, 0.6 PPB difference

Percent difference of audit levels 3-10 <±15.1%. Audit levels 1&2 <±1.5 ppb difference or <±15.1%.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

WDEQ

Audit Spreadsheet Setup Menu

Date: 06/19/18
Time: 08:45
Time Zone: MT
Auditor: Steve Mugg
Witness:

Site name: Juel Springs
Operator: MSI
Project: WDEQ QA Audits

Data Acquisition System: CR1000
S/N: 4912

Coordinates
Latitude: 42.3735
Longitude: -109.5605

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	01/27/2018
Ozone transfer std:	TAPI	M700EU	173	01/27/18
Zero air system:	TAPI	701H		NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC355044	05/13/16	05/13/19			

Standard		***Trace Level***	
NOX	8.964		
NOX	8.950		
SO2	8.741		
CO	90.56		
Propane	202.3		
Methane	614.6		

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.0002	-1.50	cc/min
Gas flow 0-200 cc/min factors:	0.9997	0.04	cc/min
Gas flow 0-20 cc/min factors:	0.9997	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.000	ppm

Site Monitoring Equipment

STATION
Juel Springs

DATE
06/19/18

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Teledyne	400E	1873	0.150 PPM
Nitric Oxide	Thermo Scientific	42i	1180430014	0.200 ppm
Nitrogen Oxides	Thermo Scientific	42i	1180430014	0.200 ppm
Nitrogen Dioxide	Thermo Scientific	42i	1180430014	0.200 ppm

METEOROLOGICAL SENSORS

Parameter	Manufacturer	Model	Serial No.	Range
Wind Speed 10 m	Climatronics	100075	76871	0 - 50 m/s
Wind Direction 10 m	Climatronics	100076	76871	360°
Temperature 2 m	RM Young	41342	4503	-30.0 to 50.0 Deg C
Temperature 9 m	RM Young	41342	3807	-30.0 to 50.0 Deg C
Precipitation	Met One	385	J8974	NA
Solar Radiation	LiCor	Li200X	PY64239	0 - 1500 W/m2
Relative Humidity	Vaisala	HMP45C	C0540013	0-100 %
Pressure	Vaisala	PYB101B	BPA1339	600 - 1060 hPa

Site: Juel Springs

Project: WDEQ QA Audits

Operator: MSI

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
6/19/2018	**Ozone**	-6.3	1.0223	-0.0021	0.9997
6/19/2018	**Nitric Oxide**	-1.4	0.9909	-0.0002	1.0000
6/19/2018	**Nitrogen Oxides**	-1.8	0.9851	0.0000	1.0000
6/19/2018	**Nitrogen Dioxide**	7.1	0.9857	0.0002	1.0000

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

METEOROLOGICAL SENSORS

Audit Date	Sensor	Audit Input	DAS Diff.	Audit Criteria
6/19/2018	**Wind Speed (10 meters)**	**m/s**	**m/s**	
		0.00	0.0	±.25 m/s < 5 m/s
		2.56	0.0	
		m/s	**%**	
		5.12	0.0	± 5%; ws > 5 m/s
		10.24	0.0	
		20.48	0.0	
		40.96	0.0	
6/19/2018	**Wind Direction (10 meters)**	**Deg**	**Deg**	
		0	1	± 5 degrees
		30	0	
		60	-1	
		90	0	
6/19/2018	**Temperature (2 meters)**	**Deg C**	**Deg C**	
		0.3	-0.2	± 1.0 degree Celsius
		16.8	0.0	
		#REF!	#REF!	
6/19/2018	**Precipitation**	**mm**	**%**	
		0.27	0.1	±10% of input
6/19/2018	**Solar Radiation**	**W/m2**	**%**	± 10%
		587.6	-0.4	
		582.6	-0.3	

6/19/2018	**Relative Humidity**	**%** 69.81 88.6 59.9	**%** 2.1 -6.5 -2.7	± 10%
6/19/2018	**Pressure**	**mm** 788.2	**mm** 0.9	± 2.3 mm Hg
6/19/2018	**Temperature (Delta T 2-10 meters)**	**Deg C** 0.1 16.8 #REF!	**Deg C** 0.03 -0.02 #REF!	± 0.1°C

AUDIT RECORD

HORIZONTAL WIND SPEED

Department of Environmental Quality

Date: **06/19/18**
Start: **16:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **76871**
K factor: **1.4**
Range: **0 - 50** **m/s**

Model: **05305**
Sensor Ht.: **10 meters**
Starting torque: **0.1** **gm cm**
Starting threshold: **0.27** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Input m/s	DAS m/s	Diff. m/s
1	0.00	0.00	0.00
2	2.56	2.56	0.00

Audit Criteria: ±.25 m/s; ws ≤ 5 m/s

Audit Point	Input m/s	DAS m/s	Diff. %
3	5.12	5.12	0.0
4	10.24	10.24	0.0
5	20.48	20.48	0.0
6	40.96	40.96	0.0

Audit Criteria: ± 5%; ws > 5 m/s

Comments: No problems noted.

AUDIT RECORD

HORIZONTAL WIND DIRECTION

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **16:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **76871**
K factor: **37**
Range: **360°**
rossarm Orientation: **180°**

Model: **05305**
Sensor Ht.: **10 meters**
Starting torque: **3** **gm cm**
Starting threshold: **0.28** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Degrees Reference	Degrees DAS	Diff. Degrees
1	0	1	1
2	30	30	0
3	60	59	-1
4	90	90	0
5	120	119	-1
6	150	150	0
7	180	179	-1
8	210	210	0
9	240	239	-1
10	270	269	-1
11	300	299	-1
12	330	329	-1

Audit Criteria ± 5 degrees

Comments: No problems were noted.

AUDIT RECORD

AMBIENT TEMPERATURE

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **16:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **29042**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **2 m**

Audit Point	Input Deg C	DAS Deg C	Diff. Deg C
1	0.3	0.1	-0.2
2	16.8	16.8	0.0

Audit Criteria: ± 1.0°C

Comments: A third audit point was not able to be performed due to the malfunction of test water heater.

AUDIT RECORD

TEMPERATURE DIFFERENCE (DELTA-T)

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **16:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site Name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **11419**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **9 m**

Audit Point	Input Deg C	2-9 Temp Diff Deg C
1	0.1	0.031
2	16.8	-0.020

Audit Criteria: ± 0.1°C

Comments: The 10m Delta Temp was out of audit specifications and will need to be inspected and recalibrated if required.

AUDIT RECORD

PRECIPITATION

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **15:00**
Finish: **16:00**
Auditor: **Steve Mugg**
Witness: **0**

Site name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Met One**
Serial No.: **J8974**
Units: **in**

Model: **385**
Sensor Ht.: **1.5 m above ground**
Funnel Diam.: **12 inch**

Audit Point	Input Inches	DAS Inches	Diff. %
1	0.27	0.27	0.1

Audit Criteria ±10% of input

Comments: No problems were noted.

AUDIT RECORD

SOLAR RADIATION

Department of Environmental Quality

Date: **6/19/18**
Start: **14:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **LiCor**
Serial No.: **PY64239**
Range: **0 - 1500 W/m2**

Model: **200X**
Sensor Ht.: **2.5 meters**

Audit Point	Input W/m2	DAS W/m2	Diff. %
1	588	585	-0.4
2	583	581	-0.3
2	562	559	-0.5

Criteria: ±10%

Comments: No problems were noted.

AUDIT RECORD

RELATIVE HUMIDITY

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **9:45**
Finish: **11:15**
Auditor: **Steve Mugg**
Witness: **0**

Site name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **Vaisala**
Serial No.: **C0540013**
Range: **0-100 %**

Model: **HMP45AC**
Sensor Ht.: **2 meters**

Audit Point	Input RH (%)	DAS RH (%)	Diff. %
1	69.8	71.9	2.1
2	88.6	82.1	-6.5
3	59.9	57.2	-2.7
4	56.6	53.2	-3.4

Criteria: ± 10%

Comments: No problems noted.

AUDIT RECORD

BAROMETRIC PRESSURE

Wyoming
Department of Environmental Quality

Date: **06/19/18**
Start: **16:30**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **0**

Site name: **Juel Springs**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Vaisala**
Serial No.: **BPA1339**
Units: **mb**

Model: **PYB101B**
Sensor Ht.: **1.5 m**

Audit Point	Input mb	DAS mb	Diff. mb
1	788.2	789.1	0.9

Audit Criteria: ±3.0 mb

Comments: No problems were noted.

WDEQ

Audit Spreadsheet Setup Menu

Date: 06/17/19
Time: 12:30
Time Zone: MT
Auditor: Steve Mugg
Witness: Adam Lenkowski

Site name: Moxa Arch
Operator: MSI
Project: WDEQ QA Audits

Data Acquisition System: CR1000
S/N: 4757

Coordinates
Latitude: 41.75056
Longitude: -109.78833

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	01/17/2019
Ozone transfer std:	TAPI	M700EU	173	01/17/19
Zero air system:	TAPI	701H		NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC476183	06/13/19	06/13/22			

Standard		***Trace Level***	
NOX:	8.7		
NO:	8.6		
SO2:	3.1		
CO	90.3		
Propane:	196.8		
Methane:	601.9		

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.0002	-1.50	cc/min
Gas flow 0-200 cc/min factors:	0.9997	0.04	cc/min
Gas flow 0-20 cc/min factors:	0.9997	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.000	ppm

Site Monitoring Equipment

STATION
Moxa Arch

DATE
06/17/19

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Teledyne	400E	2358	0.200 PPM
Nitric Oxide	Teledyne	200E	2905	0-200 PPB
Nitrogen Oxides	Teledyne	200E	2905	0-200 PPB
Nitrogen Dioxide	Teledyne	200E	2905	0-200 PPB
Sulfur Dioxide (Trace leve	Thermo	43i	616417091	0-200 PPB

METEOROLOGICAL SENSORS

Parameter	Manufacturer	Model	Serial No.	Range
Wind Speed 10 m	Climatronics	100075	5035	0 - 65 m/s
Wind Direction 10 m	Climatronics	100076	J3143C	0-360°
Temperature 2 m	RM Young	41342	11148	-50.0 to 50.0 Deg C
Temperature 9 m	RM Young	41342	11419	-50.0 to 50.0 Deg C
Precipitation	RM Young	52202	TB14075	0.1 mm per tip
Solar Radiation	LiCor	Li200X	PY64239	400 - 1100 nm
Relative Humidity	Vaisala	HMP45AC	C0540013	0-100 %
Pressure	RM Young	61302V	BPA1339	500 - 1000 hPa

PARTICULATE MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
PM10	Met One	1020	K1079	0-1000 µg/m³

PARTICULATE MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
PM10	Met One	1020	K1079	0-1000 µg/m³

Site: Moxa Arch

Project: WDEQ QA Audits

Operator: MSI

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
6/17/2019	**Ozone**	-3.3	0.9857	-0.0001	0.9999
6/17/2019	**Nitric Oxide**	10.6	1.1054	-0.3011	1.0000
6/17/2019	**Nitrogen Oxides**	6.5	1.0407	0.3821	1.0000
6/17/2019	**Nitrogen Dioxide**	28.4	1.0036	0.4311	0.9998
6/17/2019	**Sulfur Dioxide**	7.0	1.0266	0.0975	1.0000

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

METEOROLOGICAL SENSORS

Audit Date	Sensor	Audit Input	DAS Diff.	Audit Criteria
6/17/2019	**Wind Speed (10 meters)**	**m/s**	**m/s**	
		0.22	-0.2	±.25 m/s < 5 m/s
		4.92	0.0	
		m/s	**%**	
		11.97	0.0	± 5%; ws > 5 m/s
		23.72	-0.1	
		35.48	0.0	
		47.23	0.0	
6/17/2019	**Wind Direction (10 meters)**	**Deg**	**Deg**	
		0	1	± 5 degrees
		30	1	
		60	0	
		90	0	
6/17/2019	**Temperature (2 meters)**	**Deg C**	**Deg C**	
		0.1	0.2	± 1.0 degree Celsius
		17.2	0.1	
		40.1	-0.4	
6/17/2019	**Precipitation**	**mm**	**%**	
		0.61	-2.8	±10% of input

6/17/2019	**Solar Radiation**	**W/m2** 684 391.8	**%** -3.4 -2.9
6/17/2019	**Relative Humidity**	**%** 35.36 34.8 32.5	**%** -2.2 0.8 1.1
6/17/2019	**Pressure**	**mm** 803.3	**mm** -0.1
6/17/2019	**Temperature (Delta T 2-10 meters)**	**Deg C** 0.3 17.3 39.8	**Deg C** 0.00 0.03 0.06

PARTICULATE MATTER MONITORS

Audit Date	Parameter	Flow Diff (%)	Audit Criteria
6/17/2019	**PM_{10} (BAM)**	0.5%	±7.0%

AUDIT RECORD

OZONE

Wyoming Department of Environmental Quality

Date: **06/17/19**
Start: **12:30**
Finish: **16:45**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Teledyne**
Serial No.: **2358**
Sample flow: **628 cc/m**

Model: **400E**

Range: **0.200 PPM**

O_3 Audit Level	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
Zero	0.000	0.000	
2	0.011	0.011	0.0
3	0.030	0.029	-3.3
5	0.075	0.074	-1.3

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.986
Intercept:	0.000
Correlation:	0.9999

Percent difference of audit levels 3-10 <±15.1%. Audit levels 1&2 <±1.5 ppb difference or <±15.1%.

Comments: None Noted

Audit Equipment	Make	Model	ID	Certification Date
Dilution System:	TAPI	M700EU	173	01/17/2019
Ozone Standard:	TAPI	M700EU	173	01/17/19
Zero Air System:	TAPI	701H	0	NA

Ozone Transfer Standard			
Sample Freq:	NA	Cell Temperature:	NA deg C
Control Freq:	NA	Ambient Pressure:	NA "Hg
Span Setting:	NA	Certification Slope:	1.0000
		Certification Intercept:	0.0000 ppm

AUDIT RECORD

NITRIC OXIDE

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **12:30**
Finish: **16:45**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Teledyne**
Serial No.: **2905**
Sample flow: **393 cc/m**
Range: **0-200 PPB**

Model: **200E**

NO Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
5	27.3	29.9	9.5
6	57.8	62.9	8.9
7	113.2	125.1	10.6

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.1054
Intercept:	-0.3011
Correlation:	1.0000

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

OXIDES OF NITROGEN

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **12:30**
Finish: **16:45**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Teledyne**
Serial No.: **2905**
Sample flow: **393 cc/m**
Range: **0-200 PPB**

Model: **200E**

NO_x Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
5	28.6	30.4	6.5
6	60.5	63.7	5.2
7	118.5	123.5	4.2

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0407
Intercept:	0.3821
Correlation:	1.0000

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

NITROGEN DIOXIDE

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **12:00**
Finish: **16:45**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Teledyne**
Serial No.: **2905**
Sample flow: **393 cc/m**
Range: **0-200 PPB**

Model: **200E**
Converter T.: **315 Deg C**

NO_2 Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	
2	3.6	4.6	28.4
4	16.8	17.1	2.0
5	41.7	42.3	1.4

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0036
Intercept:	0.4311
Correlation:	0.9998

Converter Efficiency
97%

(≥96%), 96% - 104.1%

Comments: Level 2 input was 3.6 PPB output was 4.5 PPB -1.1 PPB difference, less than

Percent difference of audit levels 3-10 <±15.1%. Audit levels 1&2 <±1.5 ppb difference or <±15.1%.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/17/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

TRACE LEVEL SULFUR DIOXIDE

Wyoming Department of Environmental Quality

Date: **06/17/19**
Start: **12:30**
Finish: **16:45**
Audited by: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **616417091**
Sample flow: **400 cc/m**

Model: **43i**

Range: **0-200 PPB**

SO_2 Audit Level	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
Zero	0.0	0.0	NA
2	4.3	4.6	7.0
4	13.9	14.4	3.6
5	34.8	35.8	2.9

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0266
Intercept:	0.0975
Correlation:	1.0000

Percent difference of audit levels 3-10 <±15.1%. Audit levels 1&2 <±1.5 ppb difference or <±15.1%.

Comments: No Problems Noted

Audit Equipment	Make	Model	ID	Certification Date
Dilution System:	TAPI	M700EU	173	01/17/2019
Zero Air System:	TAPI	701H	0	NA
Calibration Gas:	Airgas	Multi	CC476183	06/13/19

AUDIT RECORD

HORIZONTAL WIND SPEED

Wyoming Department of Environmental Quality

Date: **06/17/19**
Start: **13:30**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Climatronics**
Serial No.: **5035**
K factor: **1.4**
Range: **0 - 50** **m/s**

Model: **100075**
Sensor Ht.: **10 meters**
Starting torque: **0.1** **gm cm**
Starting threshold: **0.27** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Input m/s	DAS m/s	Diff. m/s
1	0.22	0.00	-0.22
2	4.92	4.92	0.00

Audit Criteria: ±.25 m/s; ws ≤ 5 m/s

Audit Point	Input m/s	DAS m/s	Diff. %
3	11.97	11.97	0.0
4	23.72	23.71	-0.1
5	35.48	35.46	0.0
6	47.23	47.21	0.0

Audit Criteria: ± 5%; ws > 5 m/s

Comments: No problems noted.

AUDIT RECORD

HORIZONTAL WIND DIRECTION

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **13:30**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Climatronics**
Serial No.: **J3143C**
K factor: **30**
Range: **0-360°**
rossarm Orientation: **180°**

Model: **100076**
Sensor Ht.: **10 meters**
Starting torque: **3** **gm cm**
Starting threshold: **0.32** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Degrees Reference	Degrees DAS	Diff. Degrees
1	0	1	1
2	30	31	1
3	60	60	0
4	90	90	0
5	120	121	1
6	150	151	1
7	180	181	1
8	210	210	0
9	240	241	1
10	270	272	2
11	300	301	1
12	330	331	1

Audit Criteria ± 5 degrees

Comments: No problems noted

AUDIT RECORD

AMBIENT TEMPERATURE

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **13:30**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **11418**
Lower Range: **-50** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **2 m**

Audit Point	Input Deg C	DAS Deg C	Diff. Deg C
1	0.1	0.3	0.2
2	17.2	17.3	0.1
3	40.1	39.7	-0.4

Audit Criteria: ± 1.0°C

Comments: No problems noted.

AUDIT RECORD

TEMPERATURE DIFFERENCE (DELTA-T)

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **13:30**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site Name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **11419**
Lower Range: **-50** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **9 m**

Audit Point	Input Deg C	2-9 Temp Diff Deg C
1	0.3	0.00
2	17.3	0.03
3	39.8	0.06

Audit Criteria: ± 0.1°C

Comments: No problems were noted.

AUDIT RECORD

PRECIPITATION

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **15:00**
Finish: **16:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **Met One**
Serial No.: **J8974**
Units: **Inches**

Model: **375**
Sensor Ht.: **1.5 m above ground**
Funnel Diam.: **8 inch**

Audit Point	Input Inches	DAS Inches	Diff. %
1	0.61	0.59	-2.8

Audit Criteria ±10% of measured H2O input

Comments: No problems were noted.

AUDIT RECORD

SOLAR RADIATION

Wyoming
Department of Environmental Quality

Date: **6/17/19**
Start: **15:00**
Finish: **17:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **LiCor**
Serial No.: **PY64239**
Range: **400 - 1100 nm**

Model: **200X**
Sensor Ht.: **2.5 meters**

Audit Point	Input W/m2	DAS W/m2	Diff. %
1	684	661	-3.4
2	392	380	-2.9
3	235	227	-3.4

Criteria: ±10%

Comments: No problems were noted.

AUDIT RECORD

RELATIVE HUMIDITY

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **15:00**
Finish: **18:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sensor Mfg: **Vaisala**
Serial No.: **C0540013**
Range: **0-100 %**

Model: **HMP45AC**
Sensor Ht.: **2 meters**

Audit Point	Input RH (%)	DAS RH (%)	Diff. %
1	35.4	33.2	-2.2
2	34.8	35.5	0.8
3	32.5	33.6	1.1

Criteria: ± 10%

Comments: No problems noted.

AUDIT RECORD

BAROMETRIC PRESSURE

Date: **06/17/19**
Start: **14:00**
Finish: **15:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **BPA1339**
Units: **mb**

Model: **61302V**
Sensor Ht.: **1.5 m**

Audit Point	Input mb	DAS mb	Diff. mb
1	803.3	803.2	-0.1

Audit Criteria: ± 3.0 mb

Comments: No problems were noted.

AUDIT RECORD

PM 10

Wyoming
Department of Environmental Quality

Date: **06/17/19**
Start: **13:00**
Finish: **14:00**
Auditor: **Steve Mugg**
Witness: **Adam Lenkowski**

Site name: **Moxa Arch**
Operator: **MSI**
Project: **WDEQ QA Audits**

Sampler: **BAM (PM10)**
Serial No.: **K1079**

Make: **Met One**
Model: **1020**

Amb. Press: **601.00** **mm Hg**
Amb. Temp.: **22.0** **°C**
Leak Check: **0.46** **LPM**

Flowmeters
Model: **Deltacal**

	Audit	Site	Diff.
Flow:	16.75 lpm	16.70 lpm	-0.3%
Amb Temp:	22.0 ^{o}C	21.9 ^{o}C	-0.1
Amb Press:	601 mm Hg	598.5 mm Hg	-3

Audit Criteria:
Flow: ± 10.1%
Amb T: ± 2.1^{o}C
Amb P: ± 10.1 mmHg

Comments: No problems were noted.

WDEQ

Audit Spreadsheet Setup Menu

Wyoming Department of Environmental Quality

Date: 04/19/18
Time: 08:00
Time Zone: MT
Auditor: Steve Mugg
Witness: NA

Site name: South Pass
Operator: ARS
Project: WDEQ QA Audits

Data Acquisition System: ESC 8832 Logger
S/N:

Coordinates
Latitude: 42* 40' 41.7 " N
Longitude: 108* 43' 13.4" W

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	01/27/2018
Ozone transfer std:	TAPI	M700EU	173	01/27/18
Zero air system:	TAPI	701H	745	NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC355044	05/13/16	05/13/19			

Standard

SO2:	8.7
NO:	9.0
CO:	90.6
CH4:	202.3
Methane	614.6
NOX	9.0

Trace Level

SO2:	
NO:	
CO:	

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.0002	-1.50	cc/min
Gas flow 0-200 cc/min factors:	0.9997	0.04	cc/min
Gas flow 0-20 cc/min factors:	0.9997	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.000	ppm

Site Monitoring Equipment

STATION
South Pass

DATE
04/19/18

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Thermo	49i	616417092	0.150 PPM
Nitric Oxide	Thermo	42i	6164170907	0.150 PPB
Nitrogen Oxides	Thermo	42i	6164170907	0.150 PPB
Nitrogen Dioxide	Thermo	42i	6164170907	0.150 PPB

METEOROLOGICAL SENSORS

Parameter	Manufacturer	Model	Serial No.	Range
Wind Speed 10 m	Climatronics	100075	WY50	0 - 50 m/s
Wind Direction 10 m	Climatronics	100076	1699	360°
Temperature 2 m	RM Young	41342	17437	-30.0 to 50.0 Deg C
Temperature 9 m	RM Young	41342	17438	-30.0 to 50.0 Deg C
Precipitation	RM Young	52202	TB04376	NA
Solar Radiation	LiCor	200X	PY53166	0 - 1500 W/m2
Relative Humidity	Vaisala	HMP45C	F5030105	0-100 %
Pressure	RM Young	61202V	BP03904	600 - 1060 hPa

PARTICULATE MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
PM2.5	Met One	1020	1552	NA

Site: South Pass
Project: WDEQ QA Audits
Operator: ARS

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
4/19/2018	**Ozone**	5.6	0.9820	0.0006	0.9999
12/15/2015	**Nitric Oxide**	-5.7	0.9574	-0.0003	1.0000
12/15/2015	**Nitrogen Oxides**	-6.7	0.9536	-0.0001	0.9999
4/19/2018	**Nitrogen Dioxide**	-8.2	0.9592	-0.0002	0.9999

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

METEOROLOGICAL SENSORS

Audit Date	Sensor	Audit Input	DAS Diff.	Audit Criteria
4/19/2018	**Wind Speed (10 meters)**	**m/s**	**m/s**	
		0.22	0.0	±.25 m/s < 5 m/s
		4.92	0.0	
		m/s	**%**	
		11.97	-0.1	± 5%; ws > 5 m/s
		23.72	0.0	
		35.48	0.0	
		47.23	0.0	
4/19/2018	**Wind Direction (10 meters)**	**Deg**	**Deg**	
		30	0	± 5 degrees
		60	0	
		90	1	
		120	2	
4/19/2018	**Temperature (2 meters)**	**Deg C**	**Deg C**	
		0.0	0.0	± 1.0 degree Celsius
		15.4	0.3	
		31.5	0.4	
4/19/2018	**Precipitation**	**mm**	**%**	
		21.93	9.4	±10% of input
4/19/2018	**Solar Radiation**	**W/m2**	**%**	± 10%
		288	6.6	
		468	4.3	

4/19/2018	**Relative Humidity**	**%** 55.2 52.9 50.7	**%** 1.8 -1.8 1.0
4/19/2018	**Pressure**	**mm** 561.4	**mm** 0.3
4/19/2018	**Temperature (Delta T 2-10 meters)**	**Deg C** 0.0 15.7 32.0	**Deg C** 0.01 0.02 0.06

PARTICULATE MATTER MONITORS

Audit Date	Parameter	Main Flow Diff (%)	Audit Criteria
4/19/2018	**PM2.5 (BAM)**	-0.2%	Flow:±4%

AUDIT RECORD

OZONE

Department of Environmental Quality

Date: **04/19/18**
Start: **10:32**
Finish: **11:30**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **616417092**
Sample flow: **0.581 LPM**

Model: **49i**

Range: **0.150 PPM**

O_3 Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.000	0.000	
2	0.018	0.019	5.6
3	0.033	0.033	0.0
4	0.078	0.077	-1.3

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.982
Intercept:	0.001
Correlation:	0.9999

Percent Difference of audit levels 3-10<±15.1%. Audit levels 1&2 <±1.5ppb difference or <±15.1%

Comments: No problems noted.

Audit Equipment	Make	Model	ID	Certification Date
Dilution System:	TAPI	M700EU	173	01/27/2018
Ozone Standard:	TAPI	M700EU	173	01/27/18
Zero Air System:	TAPI	701H	745	NA

Ozone Transfer Standard			
Sample Freq:	NA	Cell Temperature:	NA deg C
Control Freq:	NA	Ambient Pressure:	NA "Hg
Span Setting:	NA	Certification Slope:	1.0000
		Certification Intercept:	0.0000 ppm

AUDIT RECORD

NITRIC OXIDE

Wyoming
Department of Environmental Quality

Date: **12/15/15**
Start: **09:00**
Finish: **10:32**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **6164170907**
Sample flow: **0.672 LPM**
Range: **0.150 PPB**

Model: **42i**

NO Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.000	0.000	
2	0.029	0.027	-5.6
3	0.060	0.057	-5.7
4	0.118	0.113	-4.2

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.9574
Intercept:	-0.0003
Correlation:	1.0000

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/27/2018
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	05/13/16

AUDIT RECORD

OXIDES OF NITROGEN

Wyoming
Department of Environmental Quality

Date: **12/15/15**
Start: **09:00**
Finish: **10:32**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **6164170907**
Sample flow: **0.672 LPM**
Range: **0.150 PPB**

Model: **42i**

NO_x Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.000	0.001	
2	0.029	0.027	-6.7
3	0.060	0.057	-5.4
4	0.118	0.113	-4.4

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.9536
Intercept:	-0.0001
Correlation:	0.9999

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/27/2018
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	05/13/16

AUDIT RECORD

NITROGEN DIOXIDE

Wyoming Department of Environmental Quality

Date: **12/15/15**
Start: **09:00**
Finish: **10:32**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **616417090**
Sample flow: **0.672 LPM**
Range: **0.150 PPB**

Model: **42i**
Last cal.: **03/12/18**

NO_2 Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.000	-0.001	
2	0.003	0.003	-8.2
3	0.023	0.022	-3.3
4	0.057	0.054	-4.8

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.9592
Intercept:	0.000
Correlation:	0.9999

Converter Efficiency
100%

Percent difference of audit levels 3-10 <±15.1%. Audit levels1&2 <±1.5 ppb difference or <±15.1%.

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	01/27/2018
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	05/13/16

AUDIT RECORD

HORIZONTAL WIND SPEED

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **09:00**
Finish: **10:45**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **Climatronics**
Serial No.: **WY50**
K factor: **1.4**
Range: **0 - 50** **m/s**

Model: **100075**
Sensor Ht.: **10 meters**
Starting torque: **1** **gm cm**
Starting threshold: **0.85** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Input m/s	DAS m/s	Diff. m/s
1	0.22	0.22	0.00
2	4.92	4.92	0.00

Audit Criteria: ±.25 m/s; ws ≤ 5 m/s

Audit Point	Input m/s	DAS m/s	Diff. %
3	11.97	11.97	-0.1
4	23.72	23.73	0.0
5	35.48	35.48	0.0
6	47.23	47.23	0.0

Audit Criteria: ± 5%; ws > 5 m/s

Comments: No problems noted.

AUDIT RECORD

HORIZONTAL WIND DIRECTION

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **09:00**
Finish: **10:45**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **Climatronics**
Serial No.: **1699**
K factor: **37**
Range: **360°**
Crossarm Orientation: **181°**

Model: **100076**
Sensor Ht.: **10 meters**
Starting torque: **3** **gm cm**
Starting threshold: **0.26** **m/s**
Starting threshold criteria: **0.5** **m/s**

Audit Point	Degrees Reference	Degrees DAS	Diff. Degrees
1	30	30	0
2	60	60	0
3	90	91	1
4	120	122	2
5	150	152	2
6	180	182	2
7	210	213	3
8	240	243	3
9	270	274	4
10	300	304	4
11	330	334	4
12	0	0	0

Audit Criteria ± 5 degrees

Comments: No problems were noted.

AUDIT RECORD

AMBIENT TEMPERATURE

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **09:00**
Finish: **10:45**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **17437**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **2 m**

Audit Point	Input Deg C	DAS Deg C	Diff. Deg C
1	0.0	0.0	0.0
2	15.4	15.7	0.3
3	31.5	31.9	0.4

Audit Criteria: ± 1.0°C

Comments: No problems noted.

AUDIT RECORD

TEMPERATURE DIFFERENCE (DELTA-T)

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **09:00**
Finish: **10:45**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **17438**
Lower Range: **-30** **Deg C**
Upper Range: **50** **Deg C**

Model: **41342**
Sensor Ht.: **9 m**

Audit Point	Input Deg C	2-9 Temp Diff Deg C
1	0.0	0.01
2	15.7	0.02
3	32.0	0.06

Audit Criteria: ± 0.1°C

Comments: No problems were noted.

AUDIT RECORD

PRECIPITATION

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **09:00**
Finish: **10:00**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **TB 04376**
Units: **mm**

Model: **52202**
Sensor Ht.: **2.0 m above ground**
Funnel Diam.: **6** **inch**

Audit Point	Input mm	DAS mm	Diff. %
1	21.93	24.00	9.4

Audit Criteria ±10% of input

Comments: No problems were noted.

AUDIT RECORD

SOLAR RADIATION

Wyoming
Department of Environmental Quality

Date: **4/19/18**
Start: **07:00**
Finish: **10:00**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Sensor Mfg: **Licor**
Serial No.: **70118**
Range: **0 - 1500 W/m2**

Model: **200X**
Sensor Ht.: **2.5 meters**

Audit Point	Input W/m2	DAS W/m2	Diff. %
1	288	307	6.6
2	468	488	4.3
3	661	686	3.8
4	754	791	4.9

Criteria: ±10%

Comments: No problems were noted.

AUDIT RECORD

RELATIVE HUMIDITY

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **7:00**
Finish: **10:00**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Sensor Mfg: **Vaisala**
Serial No.: **F1640015**
Range: **0-100 %**

Model: **HMP45AC**
Sensor Ht.: **2 meters**

Audit Point	Input RH (%)	DAS RH (%)	Diff. %
1	55.2	57.0	1.8
2	52.9	51.1	-1.8
3	50.7	51.6	1.0
4	51.3	51.7	0.4

Criteria: ± 10%

Comments: No problems noted.

AUDIT RECORD

BAROMETRIC PRESSURE

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **10:00**
Finish: **10:15**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Manufacturer: **RM Young**
Serial No.: **BP03904**
Units: **mmHg**

Model: **61202V**
Sensor Ht.: **1.5 m**

Audit Point	Input mmHg	DAS mmHg	Diff. mmHg
1	561.4	561.7	0.3

Audit Criteria: ± 2.3 mm Hg

Comments: No problems were noted.

AUDIT RECORD

PM 2.5

Wyoming
Department of Environmental Quality

Date: **04/19/18**
Start: **9:00**
Finish: **10:00**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Sampler: **BAM (PM2.5)**
Serial No.: **1552**

Make: **Met One**
Model: **1020**

Flowmeters
Model: **Deltacal**

Amb. Press: **558.00** **in. Hg**
Amb. Temp.: **2.6** **°C**
Leak Check: **0.1** **LPM**

	Audit	Site	Diff.
Flow:	16.74 lpm	16.70 lpm	-0.2%
Amb Temp:	2.1 ^{o}C	1.3 ^{o}C	-0.8
Amb Press:	558 mm Hg	561 mm Hg	3

Audit Criteria: Flow: ± 4%; Total 15.87 - 17.54 lpm
Amb T: ± 2^{o}C
Amb P: ± 10 mm

Comments: No problems were noted.

WDEQ

Audit Spreadsheet Setup Menu

Date: 10/08/19
Time: 16:10
Time Zone: MT
Auditor: Steve Mugg
Witness: NA

Site name: South Pass
Operator: ARS
Project: WDEQ QA Audits

Data Acquisition System: ESC 8832 Logger
S/N:

Coordinates
Latitude: 42* 40' 41.7 " N
Longitude: 108* 43' 13.4" W

Audit Equipment	Make	Model	S/N	Last Calibration
Dilution system:	TAPI	M700EU	173	09/23/2019
Ozone transfer std:	TAPI	M700EU	173	09/23/19
Zero air system:	TAPI	701H	745	NA

Cylinder Company: Airgas **Cylinder Type:** Multi

Cylinder A	Cert Date	Cert Expiration	Cylinder B	Cert Date	Cert Expiration
CC476183	06/13/19	06/13/22			

Standard

SO2:	3.1
NO:	8.6
CO:	90.3
CH4:	601.9
Propane	196.8
NOX	8.7

Trace Level

SO2:	
NO:	
CO:	

Duiltion system cal factors	A	B	
Diluent 0-20 lpm factors:	1.00008	0.63	cc/min
Gas flow 0-200 cc/min factors:	0.99995	0.01	cc/min
Gas flow 0-20 cc/min factors:	1.00008	0	cc/min
O_3 Transfer Standard factors:	1.0000	0.0000	ppm

Site Monitoring Equipment

STATION: South Pass

DATE: 10/08/19

AMBIENT AIR QUALITY MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
Ozone	Thermo	49i	616417092	0.150 PPM
Nitric Oxide	Thermo	42i	6164170907	0.150 PPB
Nitrogen Oxides	Thermo	42i	6164170907	0.150 PPB
Nitrogen Dioxide	Thermo	42i	6164170907	0.150 PPB

PARTICULATE MONITORS

Parameter	Manufacturer	Model	Serial No.	Range
PM2.5	Met One	1020	1552	NA

Site: South Pass

Project: WDEQ QA Audits

Operator: ARS

AMBIENT AIR QUALITY MONITORS

Audit Date	Parameter	Max Diff. (%)	DAS Slope	DAS Intercept	DAS Correlation
10/8/2019	**Ozone**	-2.8	0.9698	0.0002	1.0000
10/8/2019	**Nitric Oxide**	2.9	1.0322	-0.4232	0.9999
10/8/2019	**Nitrogen Oxides**	3.2	1.0341	-0.4536	0.9999
10/8/2019	**Nitrogen Dioxide**	-4.6	0.9542	0.1819	0.9998

Audit Criteria: Max Diff ±15%, Slope 1.000 ± 0.15: Intercept ± 3% of full scale; Correlation > 0.9950; Trace Level (Audit levels 1 - 3): Max Diff ±15% Slope 1.000 ± 0.15 OR ±1.5 ppb (Whichever is greater)

PARTICULATE MATTER MONITORS

Audit Date	Parameter	Main Flow Diff (%)	Audit Criteria
10/8/2019	**PM2.5 (BAM)**	0.1%	Flow:±4%

AUDIT RECORD

OZONE

Date: **10/08/19**
Start: **15:30**
Finish: **16:20**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **616417092**
Sample flow: **0.585 LPM**

Model: **49i**

Range: **0.150 PPM**

O_3 Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.000	0.000	
2	0.013	0.013	0.0
3	0.037	0.036	-2.7
4	0.071	0.069	-2.8

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.970
Intercept:	0.000
Correlation:	1.0000

Percent Difference of audit levels 3-10<±15.1%. Audit levels 1&2 <±1.5ppb difference or <±15.1%

Comments: No problems noted.

Audit Equipment	Make	Model	ID	Certification Date
Dilution System:	TAPI	M700EU	173	09/23/2019
Ozone Standard:	TAPI	M700EU	173	09/23/19
Zero Air System:	TAPI	701H	745	NA

Ozone Transfer Standard			
Sample Freq:	NA	Cell Temperature:	NA deg C
Control Freq:	NA	Ambient Pressure:	NA "Hg
Span Setting:	NA	Certification Slope:	0.9670
		Certification Intercept:	0.0006 ppm

AUDIT RECORD

NITRIC OXIDE

Wyoming
Department of Environmental Quality

Date: **10/08/19**
Start: **16:20**
Finish: **17:25**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **6164170907**
Sample flow: **0.678 LPM**
Range: **0.150 PPB**

Model: **42i**

NO Audit Point	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
1	0.0	0.0	
2	15.3	15.0	-2.0
3	29.8	30.1	1.0
4	69.6	71.6	2.9

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0322
Intercept:	-0.4232
Correlation:	0.9999

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	09/23/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

OXIDES OF NITROGEN

Wyoming
Department of Environmental Quality

Date: **10/08/19**
Start: **16:20**
Finish: **17:25**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **6164170907**
Sample flow: **0.678 LPM**
Range: **0.150 PPB**

Model: **42i**

NO_x Audit Point	PPM Input (X)	PPM DAS (Y)	PPM Dif (%)
1	0.0	0.0	
2	15.3	15.2	-0.7
3	29.8	29.8	0.0
4	69.6	71.8	3.2

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	1.0341
Intercept:	-0.4536
Correlation:	0.9999

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	09/23/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

NITROGEN DIOXIDE

Wyoming
Department of Environmental Quality

Date: **10/08/19**
Start: **16:20**
Finish: **17:25**
Auditor: **Steve Mugg**
Witness: **NA**

Site Name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Analyzer make: **Thermo**
Serial No.: **616417090**
Sample flow: **0.672 LPM**
Range: **0.150 PPB**

Model: **42i**
Last cal.: **07/31/19**

NO_2 Audit Point	PPB Input (X)	PPB DAS (Y)	PPB Dif (%)
1	0.0	0.0	
2	3.0	3.0	0.0
3	15.4	15.3	-0.6
4	32.4	30.9	-4.6

Linear Regression: (Y=PPM Corrected, X=PPM Input)

Audit Statisitics	
Slope:	0.9542
Intercept:	0.182
Correlation:	0.9998

Converter Efficiency
100%

Percent difference of audit levels 3-10 <±15.1%. Audit levels1&2 <±1.5 ppb difference or <±15.1%.

Comments: No problems were noted.

Audit Equipment	Make	Model	Certification Date
Dilution System:	TAPI	M700EU	09/23/2019
Zero Air System:	TAPI	701H	NA
Calibration Gas:	Airgas	Multi	06/13/19

AUDIT RECORD

PM 2.5

Wyoming
Department of Environmental Quality

Date: **10/08/19**
Start: **16:00**
Finish: **17:00**
Auditor: **Steve Mugg**
Witness: **NA**

Site name: **South Pass**
Operator: **ARS**
Project: **WDEQ QA Audits**

Sampler: **BAM (PM2.5)**
Serial No.: **1552**

Make: **Met One**
Model: **1020**

Flowmeters
Model: **Deltacal**

Amb. Press: **555.00** **in. Hg**
Amb. Temp.: **13.9** **°C**
Leak Check: **0.5** **LPM**

	Audit	Site	Diff.
Flow:	16.69 lpm	16.70 lpm	0.1%
Amb Temp:	13.9 °C	14.4 °C	0.5
Amb Press:	555 mm Hg	558 mm Hg	3

Audit Criteria: Flow: ± 4.1%; Total 15.87 - 17.54 lpm
Amb T: ± 2.1°C
Amb P: ± 10.1 mm

Comments: No problems were noted.

APPENDIX – AQS AMP 350 Raw Data Reports

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

User ID: KHURSHMAN

RAW DATA REPORT

Report Request ID: 1861810

Report Code: AMP350

Aug. 7, 2020

GEOGRAPHIC SELECTIONS

Tribal Code	State	County	Site	Parameter	POC	City	AQCR	UAR	CBSA	CSA	EPA Region
	56	035	1002								
	56	037	0300								
	56	013	0099								
	56	035	0700								

PROTOCOL SELECTIONS

Parameter Classification	Parameter	Method	Duration
CRITERIA	44201		

SELECTED OPTIONS

Option Type	Option Value
RAW DATA EVENTS	INCLUDE EVENTS
DAILY STATISTICS	MAXIMUM
AGENCY ROLE	PQAO
UNITS	STANDARD
INCLUDE NULLS	YES
MERGE PDF FILES	YES

SORT ORDER

Order	Column
1	STATE_CODE
2	COUNTY_CODE
3	SITE_ID
4	PARAMETER_CODE
5	POC

DATE CRITERIA

Start Date	End Date
2019 04 27	2019 04 29

APPLICABLE STANDARDS

Standard Description
Ozone 1-hour 1979

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
RAW DATA REPORT

Aug. 7, 2020

(44201) Ozone

SITE ID: 56-013-0099 POC: 1
COUNTY: (013) Fremont
CITY: (00000) Not in a city
SITE ADDRESS: South Pass WyDot
SITE COMMENTS:
MONITOR COMMENTS:

STATE: (56) Wyoming
AQCR: (241) CASPER
URBANIZED AREA: (0000) NOT IN AN URBAN AREA
LAND USE: FOREST
LOCATION SETTING: RURAL

CAS NUMBER: 10028-15-6
LATITUDE: 42.5299990009
LONGITUDE: -108.720003
UTM ZONE:
UTM NORTHING:
UTM EASTING:
ELEVATION-MSL: 2526
PROBE HEIGHT:

SUPPORT AGENCY: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality
MONITOR TYPE: SPM
COLLECTION AND ANALYSIS METHOD: (047) INSTRUMENTAL ULTRA VIOLET
PQAO: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality

REPORT FOR: APRIL 2019

DURATION: 1 HOUR
UNITS: Parts per million
MIN DETECTABLE: .005

DAY	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	OBS	MAXIMUM
1																									0	
2																									0	
3																									0	
4																									0	
5																									0	
6																									0	
7																									0	
8																									0	
9																									0	
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25																									0	
26																									0	
27	.042	.041	.038	.037	.036	.037	.048	.054	.050	.051	.052	.054	.058	.061	.060	.059	.057	.053	.052	.052	.051	.051	.051	AY	23	.061
28	.045ro	.040ro	.040ro	.041ro	.036ro	.034ro	.037ro	.042ro	.052ro	.053ro	.055ro	.060ro	.070ro	.079ro	.084ro	.087ro	.088ro	.092ro	.062ro	.037ro	.037ro	.038ro	.038ro	.039ro	24	.092
29	.039	.038	.038	.039	.040	.040	.040	.040	.039	.040	.040	.041	.042	.042	.041	.040	.040	.039	.039	.039	.039	.039	.038	.037	24	.042
30																									0	
31																									0	
NO.:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2		
MAX:	.045	.041	.040	.041	.040	.040	.048	.054	.052	.053	.055	.060	.070	.079	.084	.087	.088	.092	.062	.052	.051	.051	.051	.039		
AVG:	.0420	.0397	.0387	.0390	.0373	.0370	.0417	.0453	.0470	.0480	.0490	.0517	.0567	.0607	.0617	.0620	.0617	.0613	.0510	.0427	.0423	.0427	.0423	.0380		

MONTHLY OBSERVATIONS: 71 MONTHLY MEAN: .0476 MONTHLY MAX: .092

Note: Qualifier codes with regional concurrence are shown in upper case, and those without regional review are shown in lower case. An asterisk ("*") indicates that the region has reviewed the value and does not concur with the qualifier.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
RAW DATA REPORT

Aug. 7, 2020

(44201) Ozone

SITE ID: 56-035-0700 POC: 1
COUNTY: (035) Sublette
CITY: (00000) Not in a city
SITE ADDRESS: Big Piney Site #3
SITE COMMENTS:
MONITOR COMMENTS:

STATE: (56) Wyoming
AQCR: (243) WYOMING
URBANIZED AREA: (0000) NOT IN AN URBAN AREA
LAND USE: RESIDENTIAL
LOCATION SETTING: RURAL

CAS NUMBER: 10028-15-6
LATITUDE: 42.4863610009
LONGITUDE: -110.098861
UTM ZONE:
UTM NORTHING:
UTM EASTING:
ELEVATION-MSL: 2076
PROBE HEIGHT:

SUPPORT AGENCY: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality
MONITOR TYPE: SPM
COLLECTION AND ANALYSIS METHOD: (047) INSTRUMENTAL ULTRA VIOLET
PQAO: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality

REPORT FOR: APRIL 2019

DURATION: 1 HOUR
UNITS: Parts per million
MIN DETECTABLE: .005

DAY	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	OBS	MAXIMUM
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28	.040ro	.040ro	.040ro	.042ro	.042ro	.044ro	.045ro	.050ro	.051ro	.055ro	.067ro	.076ro	.081ro	.081ro	.079ro	.072ro	.070ro	.068ro	.060ro	.050ro	.043ro	.037ro	.033ro	.033ro	24	.081
29	.030	.032	.033	.035	.035	.035	.036	.037	.039	.044	.044	.045	.045	.047	.047	.047	.048	.041	.038	.036	.035	.035	.035	.034	24	.048
30																									0	
31																									0	
NO.:	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
MAX:	.040	.040	.040	.042	.042	.044	.045	.050	.051	.055	.067	.076	.081	.081	.079	.072	.070	.068	.060	.050	.043	.042	.041	.040		
AVG:	.0363	.0367	.0377	.0383	.0363	.0363	.0373	.0420	.0460	.0490	.0547	.0597	.0613	.0620	.0610	.0570	.0563	.0530	.0490	.0447	.0403	.0380	.0363	.0357		

MONTHLY OBSERVATIONS: 72 MONTHLY MEAN: .0460 MONTHLY MAX: .081

Note: Qualifier codes with regional concurrence are shown in upper case, and those without regional review are shown in lower case. An asterisk ("*") indicates that the region has reviewed the value and does not concur with the qualifier.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
RAW DATA REPORT

Aug. 7, 2020

(44201) Ozone

SITE ID: 56-035-1002 POC: 1
COUNTY: (035) Sublette
CITY: (00000) Not in a city
SITE ADDRESS: Juel Spring - 20 miles NW of Farson on the west side of US Highway 191
SITE COMMENTS:
MONITOR COMMENTS:

STATE: (56) Wyoming
AQCR: (243) WYOMING
URBANIZED AREA: (0000) NOT IN AN URBAN AREA
LAND USE: INDUSTRIAL
LOCATION SETTING: RURAL

CAS NUMBER: 10028-15-6
LATITUDE: 42.3734991609
LONGITUDE: -109.5604983
UTM ZONE:
UTM NORTHING:
UTM EASTING:
ELEVATION-MSL: 2145
PROBE HEIGHT:

SUPPORT AGENCY: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality
MONITOR TYPE: SPM
COLLECTION AND ANALYSIS METHOD: (087) INSTRUMENTAL ULTRA VIOLET ABSORPTI
PQAO: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality

REPORT FOR: APRIL 2019

DURATION: 1 HOUR
UNITS: Parts per million
MIN DETECTABLE: .005

DAY	HOUR 0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	OBS	MAXIMUM
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28	.036ro	.035ro	.037ro	.036ro	.031ro	.029ro	.029ro	.039ro	.053ro	.055ro	.057ro	.070ro	.074ro	.076ro	.075ro	.073ro	.075ro	.074ro	.066ro	.054ro	.044ro	.039ro	.034ro	.035ro	24	.076
29	.035	.035	.035	.035	.036 3	.026 3	.029 3	.036 3	.045 3	.045 3	.045 3	.045 3	.045 3	.044 3	.043 3	.042 3	.042 3	.041 3	.040 3	.040 3	.039 3	.039 3	.038 3	.039 3	24	.045
30																									0	
31																									0	
NO.:	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
MAX:	.037	.035	.037	.036	.036	.031	.039	.041	.053	.055	.057	.070	.074	.076	.075	.073	.075	.074	.066	.054	.046	.043	.042	.040		
AVG:	.0360	.0343	.0360	.0350	.0333	.0287	.0323	.0387	.0473	.0503	.0517	.0570	.0597	.0597	.0593	.0577	.0573	.0560	.0523	.0477	.0430	.0403	.0380	.0380		

MONTHLY OBSERVATIONS: 71 MONTHLY MEAN: .0455 MONTHLY MAX: .076

Note: Qualifier codes with regional concurrence are shown in upper case, and those without regional review are shown in lower case. An asterisk ("*") indicates that the region has reviewed the value and does not concur with the qualifier.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
RAW DATA REPORT

Aug. 7, 2020

(44201) Ozone

SITE ID: 56-037-0300 POC: 1
COUNTY: (037) Sweetwater
CITY: (00000) Not in a city
SITE ADDRESS: Moxa
SITE COMMENTS:
MONITOR COMMENTS:

STATE: (56) Wyoming
AQCR: (243) WYOMING
URBANIZED AREA: (0000) NOT IN AN URBAN AREA
LAND USE: DESERT
LOCATION SETTING: RURAL

CAS NUMBER: 10028-15-6
LATITUDE: 41.7505560009
LONGITUDE: -109.788333
UTM ZONE:
UTM NORTHING:
UTM EASTING:
ELEVATION-MSL: 1966
PROBE HEIGHT:

SUPPORT AGENCY: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality
MONITOR TYPE: SPM
COLLECTION AND ANALYSIS METHOD: (087) INSTRUMENTAL ULTRA VIOLET ABSORPTI
PQAO: (1188) Wyoming Air Quality Division, Dept Of Environmental Quality

REPORT FOR: APRIL 2019

DURATION: 1 HOUR
UNITS: Parts per million
MIN DETECTABLE: .005

DAY	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	OBS	MAXIMUM
1																									0	
2																									0	
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27	.044	.045	.042	.042	.038	.040	.041	.045	.048	.051	.052	.054	.057	.058	.061	.063	.060	.057	.054	.049	.043	.036	.031	.030	24	.063
28	.024ro	.024ro	.026ro	.028ro	.028ro	.029ro	.030ro	.041ro	.048ro	.050ro	.050ro	.053ro	.059ro	.069ro	.074ro	.072ro	.076ro	.079ro	.075ro	.068ro	.061ro	.053ro	.047ro	.037ro	24	.079
29	.035	.035	BF	BF	.037	.037	.037	.038	.040	.041	.044	.045	.045	.047	.048	.048	.047	.045	.046	.046	.044	.037	.034	.035	22	.048
30																									0	
31																									0	
NO.:	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
MAX:	.044	.045	.042	.042	.038	.040	.041	.045	.048	.051	.052	.054	.059	.069	.074	.072	.076	.079	.075	.068	.061	.053	.047	.037		
AVG:	.0343	.0347	.0340	.0350	.0343	.0353	.0360	.0413	.0453	.0473	.0487	.0507	.0537	.0580	.0610	.0610	.0610	.0603	.0583	.0543	.0493	.0420	.0373	.0340		

MONTHLY OBSERVATIONS: 70 MONTHLY MEAN: .0465 MONTHLY MAX: .079

Note: Qualifier codes with regional concurrence are shown in upper case, and those without regional review are shown in lower case. An asterisk ("*") indicates that the region has reviewed the value and does not concur with the qualifier.

QUALIFIER CODES:

Qualifier Code	Qualifier Description	Qualifier Type
3	Field Issue.	QA
AY	Q C Control Points (zero/span).	NULL
BF	Precision/Zero/Span.	NULL
ro	Stratospheric Ozone Intrusion.	REQEXC

Note: Qualifier codes with regional concurrence are shown in upper case, and those without regional concurrence are shown in lower case.

From:
Wyoming Tribune Eagle
702 W. Lincolnway
Cheyenne, WY 82001

Affidavit of Publication

Description of advertisement:
PUBLIC NOTICE STATE OF WY
Published: 08/23/2020
Legal publication number: 198641

THE STATE OF WYOMING) ss.
County of Laramie)

I, Clarence Engel, do solemnly swear that I am the Publisher's Agent of the **Wyoming Tribune Eagle,** a newspaper of general circulation published in the **County of Laramie, State of Wyoming**; that the notice, of which the attached is a true copy, was published in said newspaper for One publications, the first having been made on the 23rd day of August, 2020, and the last publication having been made on the 23rd day of August, 2020; that said notice was published in the regular and entire issue of said newspaper during the period and times of publication aforesaid and that the notice was published in the newspaper proper, and not in a supplement.

Publication fees: $170.40

PUBLIC NOTICE
STATE OF WYOMING
Department of
Environmental Quality
Air Quality Division
Stratospheric Ozone
Intrusion Exceptional
Event Demonstration

The Wyoming Department of Environmental Quality Air Quality Division (AQD) has notified EPA Region 8 that exceedances of the 8-hour ozone National Ambient Air Quality Standard collected at the Moxa, South Pass, Juel Springs, and Big Piney air quality monitoring stations on April 28, 2019 are proposed to be flagged as due to an exceptional event under 40 CFR 50.14, Treatment of air quality monitoring data influenced by exceptional events. The AQD has produced a comprehensive demonstration in support of its notification to flag the exceedances cited above. The AQD is soliciting comments from the interested public on this demonstration packet. The demonstration packet is available for public comment and the public will be allowed a period of thirty (30) days to submit written comments.

Notice is hereby given that the State of Wyoming, Department of Environmental Quality, Division of Air Quality, proposes to flag this data as influenced by an exceptional event.

Comments can be submitted to the AQD's Monitoring Supervisor, Ms. Cara Keslar, Ambient and Emission Monitoring Supervisor, Air Quality Division, Department of Environmental Quality, 200 West 17th Street, 3rd Floor, Cheyenne, Wyoming 82002 or by fax to (307) 635-1784. Comments may also be submitted electronically through the following website: (http://deq.wyoming.gov/aqd/resources/public-comments-online/). Comments submitted by email will not be accepted. Interested parties may examine the documentation packet and relevant supporting materials on AQDs website (http://deq.wyoming.gov/aqd/monitoring/resources/exceptional-events/). This material may also be viewed online, at the above URL, by appointment to use a computer kiosk at the Departments office locations in Cheyenne, Casper, Sheridan, or Lander. In accordance with the Americans with Disabilities Act, special assistance or alternate formats will be made available upon request for individuals with disabilities. Para espanol visite http://deq.wyoming.gov/.

Public comments must be received no later than September 24, 2020. All comments received by the close of business on September 24, 2020 will be submitted to EPAs Region 8 along with the demonstration packet to be considered in arriving at a final determination of treatment of data influenced by exceptional events and will be retained on file in the Cheyenne office.

August 23, 2020
NO. 198641

Subscribed and sworn to before me,

this 24th

Day of August, 2020

My commission expires:

LASHA HERNANDEZ - NOTARY PUBLIC
COUNTY OF LARAMIE STATE OF WYOMING
MY COMMISSION EXPIRES OCT 28, 2023

Notary Public

Received
AUG 27 2020
Air Quality Division

*** Proof of Publication ***

Casper Star-Tribune
P.O. Box 80, Casper, WY 82602-0080, ph 307-266-0500

AFFIDAVIT OF PUBLICATION

STATE OF WYOMING)
COUNTY OF NATRONA)

I, the undersigned, being a person in the employ of the Casper Star-Tribune, a newspaper published in CASPER, NATRONA COUNTY, WYOMING, and, knowing the facts herein set forth do so solemnly swear that a copy of the notice as per clipping attached was printed and published

Daily Weekly

In the regular and entire issue of said newspaper, and not in any supplement thereof, for 1 Consecutive Days Weeks

commencing with issue dated Aug 23, 2020
ending with issue dated Aug 23, 2020

DEQ Air Quality Division
Kristina Hooper-Barden
200 WEST 17TH STREET, 3RD FLR
CHEYENNE WY 82002

ORDER NUMBER 68395

Sami Bowman
Signed

Subscribed in my presence and sworn to before me this
25th day of Aug 2020

Rebecca S. Harris

NOTARY PUBLIC
REBECCA S. HARRIS
STATE OF WYOMING
COUNTY OF NATRONA
My Commission Expires June 13, 2024

RECEIVED
AUG 27 2020
AIR QUALITY DIVISION

Section: Legal Notices
Category: 925 Misc Legals
PUBLISHED ON: 08/23/2020

TOTAL AD COST:	159.88
FILED ON:	8/24/2020

*** Proof of Publication ***

PUBLIC NOTICE
STATE OF WYOMING
Department of Environmental Quality – Air Quality Division
Stratospheric Ozone Intrusion Exceptional Event Demonstration

The Wyoming Department of Environmental Quality – Air Quality Division (AQD) has notified EPA Region 8 that exceedances of the 8-hour ozone National Ambient Air Quality Standard collected at the Moxa, South Pass, Juel Springs, and Big Piney air quality monitoring stations on April 28, 2019 are proposed to be flagged as due to an exceptional event under 40 CFR 50.14, "Treatment of air quality monitoring data influenced by exceptional events." The AQD has produced a comprehensive demonstration in support of its notification to flag the exceedances cited above. The AQD is soliciting comments from the interested public on this demonstration packet. The demonstration packet is available for public comment and the public will be allowed a period of thirty (30) days to submit written comments.

Notice is hereby given that the State of Wyoming, Department of Environmental Quality, Division of Air Quality, proposes to flag this data as influenced by an exceptional event.

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Public comments must be received no later than September 24, 2020. All comments received by the close of business on September 24, 2020 will be submitted to EPA's Region 8 along with the demonstration packet to be considered in arriving at a final determination of treatment of data influenced by exceptional events and will be retained on file in the Cheyenne office.

Published: August 23, 2020
Legal No: 68395

SUBLETTE EXAMINER **Pinedale, Wyoming**

AFFIDAVIT OF PUBLICATION
Sublette Examiner
Pinedale, Wyoming

STATE OF WYOMING
)ss.
County of Sublette

I, Mark Tesoro, do hereby, upon my oath, depose and say that I am the Publisher of the SUBLETTE EXAMINER NEWSPAPER, a ONCE-weekly newspaper published in the Town of Pinedale, County of Sublette, in the State of Wyoming; and that said newspaper has a general circulation in said County and State; and that the legal notice herein attached was published in said newspaper for the full period of 1 consecutive issues/weeks; the first publication being on the 25 day of August, 2020, and the last publication being on the 25 day of August, 2020; and that said advertisement appeared in each and every number of said newspaper during the period of publication as above stated.

(Signed)

Mark Tesoro, Publisher

State of Wyoming
SS
County of Sublette

Subscribed in my presence and sworn to before me on this 25 day of August A.D., 2020, by Mark Tesoro, Publisher.

Notary Signature

EUNICE I. ALLGOOD NOTARY PUBLIC
COUNTY OF SUBLETTE STATE OF WYOMING
MY COMMISSION EXPIRES 11-18-23

PUBLIC NOTICE

PUBLIC NOTICE
STATE OF WYOMING
Department of Environmental Quality – Air Quality Division
Stratospheric Ozone Intrusion Exceptional Event Demonstration

The Wyoming Department of Environmental Quality – Air Quality Division (AQD) has notified EPA Region 8 that exceedances of the 8-hour ozone National Ambient Air Quality Standard collected at the Moxa, South Pass, Juel Springs, and Big Piney air quality monitoring stations on April 28, 2019 are proposed to be flagged as due to an exceptional event under 40 CFR 50.14, "Treatment of air quality monitoring data influenced by exceptional events." The AQD has produced a comprehensive demonstration in support of its notification to flag the exceedances cited above. The AQD is soliciting comments from the interested public on this demonstration packet. The demonstration packet is available for public comment and the public will be allowed a period of thirty (30) days to submit written comments.

Notice is hereby given that the State of Wyoming, Department of Environmental Quality, Division of Air Quality, proposes to flag this data as influenced by an exceptional event.

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Public comments must be received no later than September 20, 2020. All comments received by the close of business on September 24, 2020 will be submitted to EPA's Region 8 along with the demonstration packet to be considered in arriving at a final determination of treatment of data influenced by exceptional events and will be retained on file in the Cheyenne office.

Public Notice #4588 published in the *Sublette Examiner* on August 25, 2020.

Elaine Crumpley

The upshot seems to be that this stratospheric intrusion won't dramatically change the Upper Green River Basin statistics. However, it certainly raises a lot of questions about the incredible amount of work they put into the scrutiny of this. Why don't they spend their time improving things that need to be changed...ie- "business as usual" use of outdated venting and blowdown practices?
What is really frustrating is that this document likely represents hundreds of DEQ's man-hours of brainwork and devotion, while our pleas for analysis of emission reduction options have yielded no apparent efforts. Instead of spending an inordinate amount of time looking at this one event that will not change our non-attainment status, they should be devoting their time and energy to find Innovative and better ways to reduce emissions. Looking forward to working with you for better air quality here in the Upper Green.
Thank you,
Elaine Crumpley

Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

DEQ

Todd Parfitt, Director

October 20, 2020

Ms. Elaine Crumpley
PO Box 1123
Pinedale, WY 82941

Re: Exceptional Event Demonstration Package for the Environmental Protection Agency Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming Ozone Standard Exceedances - April 28, 2019 Comment Response

Dear Ms. Crumpley,

The Wyoming Department of Environmental Quality, Air Quality Division (AQD) acknowledges receipt of a September 14, 2020 comment regarding the Exceptional Event Demonstration Package for the Environmental Protection Agency - Big Piney, Juel Springs, Moxa Arch, and South Pass, Wyoming Ozone Standard Exceedances - April 28, 2019 (Demonstration Package). The AQD thanks you for taking the time to review and comment on the Demonstration Package.

The comment raised concern about the amount of staff time to prepare the demonstration package. Your comment is astute regarding the requisite staff time to prepare a comprehensive demonstration package to satisfy all of the requirements within 40 CFR 50.14 "Treatment of air quality monitoring data influenced by exceptional events" to show that the exceedance would not have occurred in the absence of the natural/exceptional event. The AQD considers the stratospheric ozone intrusion event to be of significance because of the reliance on ambient data to determine compliance with the National Ambient Air Quality Standards (NAAQS). As such, requisite staff resources were expended to prepare the comprehensive demonstration package per 40 CFR 50.14 so that the exceedance data may be properly flagged and concurred with by EPA in order for those data to be handled correctly and reflect the monitor design values.

The comment expressed that the stratospheric ozone intrusion event won't change the Upper Green River Basin (UGRB) statistics or nonattainment status. The numerous exceedances of the 8-hour ozone NAAQS at Big Piney, Juel Springs, Moxa Arch, and South Pass will affect future years design values, with the potential of a NAAQS violation. As two of the exceedances from this event occurred at stations in the UGRB ozone nonattainment area, correctly flagging and characterizing these data is especially critical.

The AQD thanks you for the comment, while out of scope for the Demonstration Package, that staff time should be devoted to things that need to be changed (i.e., use of outdated venting and blowdown practices) as well as to the analysis of innovative emission reduction options for the UGRB. The Monitoring Section will consult with the AQD's Ozone Team on the comments raised regarding the UGRB.

The AQD works daily to protect, conserve, and enhance the quality of Wyoming's air resource throughout the entire State. The AQD encourages your continued interest and involvement regarding air quality in the Upper Green River Basin.

The AQD appreciates the time you spent reviewing the Demonstration Package and for your comment. The comment, Demonstration Package, and response will be sent to EPA Region 8.

Sincerely,

Cara Keslar
Air Quality Division Monitoring Section Supervisor

cc: Nancy Vehr, Air Quality Division Administrator